SCIENTIFIC AMERICAN SUPPLEMENT. No. 1292

Copyright, 1900, by Munn & Co.

Scientific American, established 1845.
Scientific American Supplement, Vol. L, No. 1292. NEW YORK, OCTOBER 6, 1900. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

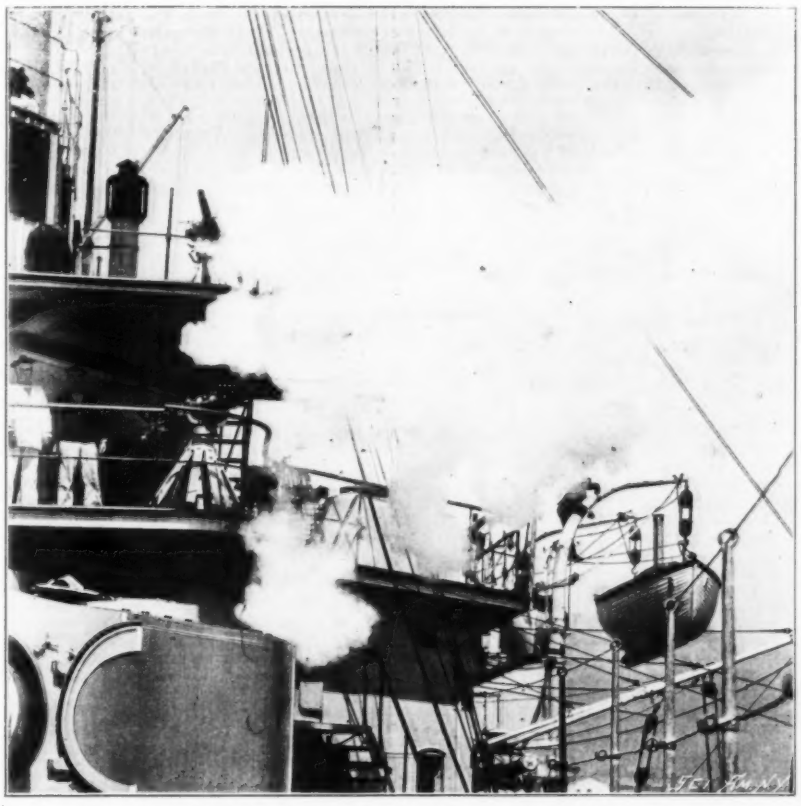
THE FRENCH NAVY.

THE gathering together of a nation's fleets in a grand naval review, such as that which has recently occurred at Cherbourg, gives a more favorable impression of the naval strength of the people than any mere recital upon paper, or portrayal by means of diagrams or photographs. While, to the trained expert, a glance through the official tables of battleships, cruisers, etc., will convey an adequate idea of the strength of the navy for attack and defense, it requires for the laymen the evidence afforded by the mile-long lines of a first-class naval review to convey an adequate impression of numbers and fighting power. Although it has been well known to those who follow intelligently the progress of the world's navies that the first line of battle of the French navy was comparable, ship for ship, with that of any other nation, the public seems to have been positively surprised at the display which was recently made on the north coast of France.

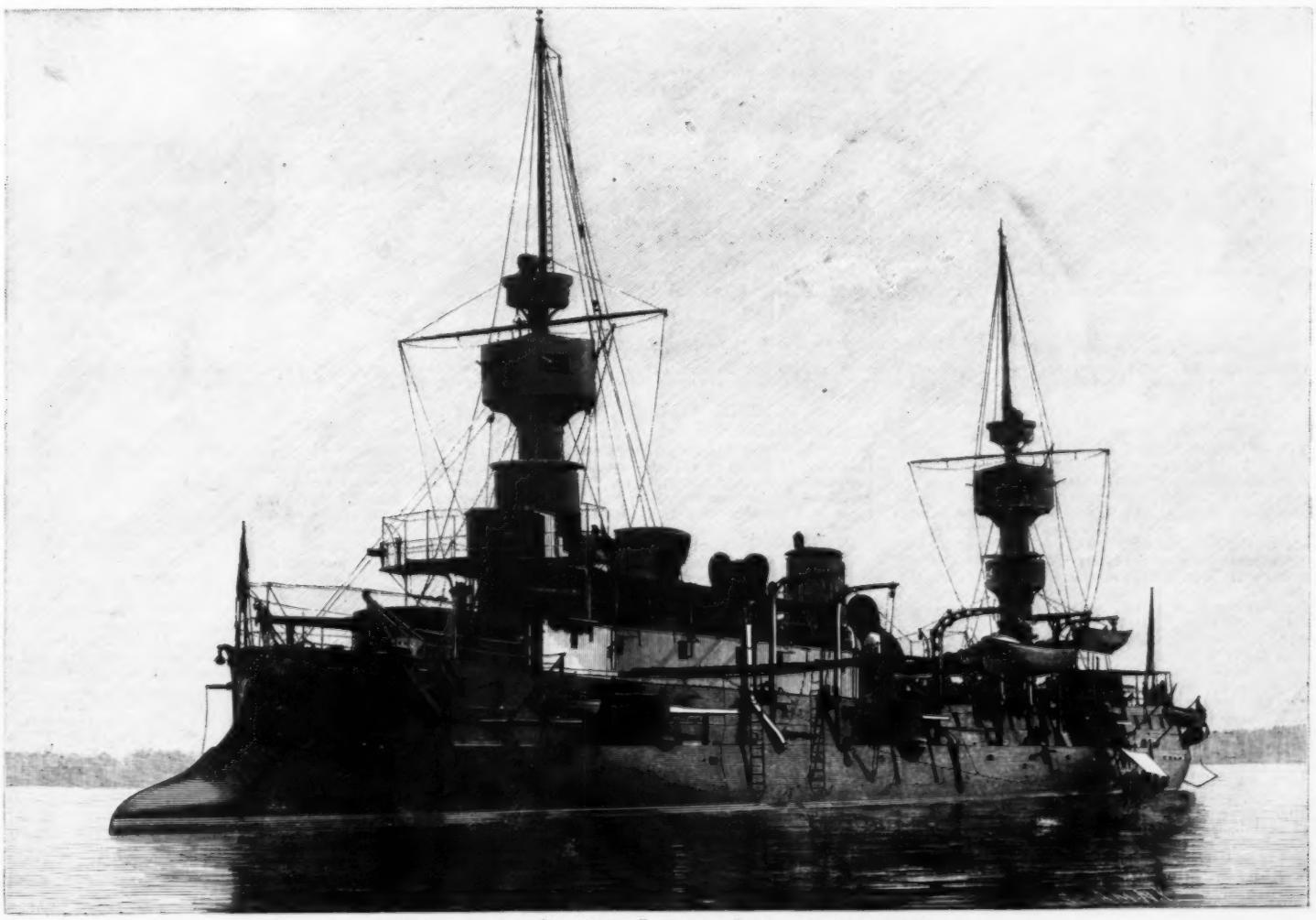
There is no navy of the world that is so distinquished from all other navies by the unique character of its ships as is that of France, and there is no other in which such wide diversity of design is shown among the ships themselves. Go where you will, you may pick out a French battleship or cruiser at first sight by the towering upper works, the massive military masts, each with its closed-in battery of guns, and by other characteristic features of ships which sail beneath the tricolor.

In naval construction, as in most fields of engineering, the French have always worked with a free hand, and great credit is due them for the fact that they have so frequently led the way in improvements which have subsequently been adopted and become standard among the navies of the world. While they may have made mistakes, as they themselves are ready to admit, they have generally been quick to recognize and rectify them. Among the valuable features upon which the French naval architects have always insisted, may be mentioned the continuous belt of armor from stem to stern at the water line, and a high command for the guns; and if it had not been for the excessive top weights in the way of lofty and massive military masts and the tendency to pile Pelion on Ossa in the matter of boat decks and special gun platforms, the early French ships of lofty freeboard would have been well able to carry their guns in any kind of weather. As it was, some of these ships after trial had to return to the dock yards to have their masts cut down or replaced by simple pole masts, and considerable sections of the upper works removed altogether. The latest ships of the French navy of the "Charles Martel" and "Charlemagne" type, however, have been free from these defects, and except for some defects in the armor distribution, it would be difficult to find more handsome and effective fighting ships on the high seas. A French battleship generally "looks the part."

The French navy at the present writing consists of about 150 ships built and building. Adopting the method of classification which is used in the SCIENTIFIC AMERICAN series on the navies of the world, in which vessels are rated according



A SALUTE FROM THE BRIDGE OF THE FIRST-CLASS BATTLESHIP "BRENNUS."



ARMORED CRUISER "CHANZY." "BRUIX" CLASS OF FOUR SHIPS.

Displacement, 4,792 tons. **Speed,** 18·2 knots. **Normal Coal Supply,** 413 tons. **Armor:** Continuous belt, 3½ inches; deck, 2 inches; gun positions, 2 inches. **Armament,** two 7·6-inch B. L. guns, six 5·5-inch rapid-fire, four 2·5-inch rapid-fire, six 1·8-inch, six 1·4-inch rapid-fire. **Torpedo Tubes,** 5. **Complement.** 375. **Date,** 1898.

THE FRENCH NAVY.

to their age, we find that there are fourteen battleships which are ten years old or less, nine from ten to twenty years old, while of battleships between twenty and twenty-five years old, of which some have been rearmed and refitted, there are twelve. There are fourteen coast defense vessels, twenty-four armored cruisers, forty protected cruisers and forty-two small cruisers and gun boats. The torpedo boat fleet consists of 324 vessels, varying in size from small craft of 30 tons up to destroyers of over 300 tons displacement.

Because of the great diversity in design, French warships are not so readily classified as those of some other navies. The most powerful group of vessels is that composed of the four battleships of the "Charles Martel" type, including the "Carnot," "Jauréguiberry," "Masséna" and "Bouvet." These vessels carry their heavy guns in four separate turrets, one forward and one aft and one on either beam. They all, with the exception of the "Jauréguiberry," carry 5·5 inch guns of the secondary battery in separate turrets, protected with 4-inch armor; the "Jauréguiberry" carries these guns in pairs in four turrets. The quadrilateral arrangement permits an extremely heavy end-on fire, for which in the case of the "Carnot" type there is available one 12 inch gun, two 8-inch guns, four 5·5-inch guns and four 4-inch rapid-fire guns. So far as the main battery is concerned, the "Carnot" can deliver a heavier end-on fire than the "Oregon" or "Iowa," it being possible to train three heavy guns ahead or astern as against two. On the other hand, the broadside fire is weaker, only three guns being available, as against four guns in the case of the "Oregon."

The 12-inch guns weigh 46 tons, and fire a 644-pound projectile, with a velocity of 2,625 feet per second, and an energy of 30,750 foot tons; the 10·8-inch gun weighs 35 tons, and fires a 476-pound projectile, with a velocity of 2,625 foot seconds, and a muzzle energy of 22,750 foot tons. The 5·5-inch gun of the secondary battery has a muzzle energy of 3,100 foot tons which is light compared with the muzzle energy of 5,818 foot tons, which will be obtained by the new 6-inch gun in our own navy. This is somewhat compensated for by the battery of eight 4-inch guns which is mounted on the superstructure deck at an elevation of 35 to 40 feet above the sea. In the later vessels, like the "Brennus" and the "Charlemagne," the French have placed the main battery in two turrets, one forward and one aft, upon the center line of the vessel. The "Brennus" carries two 13·4-inch guns forward and one of the same caliber aft, while the secondary battery consists of ten 6·4-inch rapid-fire guns carried within a central citadel of 4-inch armor. The 13·4-inch guns have a muzzle energy 44,230 foot tons.

The "Charlemagne," "St. Louis" and "Gaulois" are sister ships of 11,275 tons and 18 knots speed. They carry four 12-inch guns in two turrets, while the secondary battery of ten 5·5 inch guns is carried in broadside behind a citadel of 3-inch steel, and upon the boat deck. The vessels of the "Carnot" and "Charlemagne" classes have a displacement of between 11,000 and 12,000 tons, and speed of 18 knots. Two other vessels similar to the "Charlemagne," but of slightly larger dimensions, are under construction, but they are improved by the substitution of 6·4-inch guns in place of 5·5-inch guns in the secondary battery.

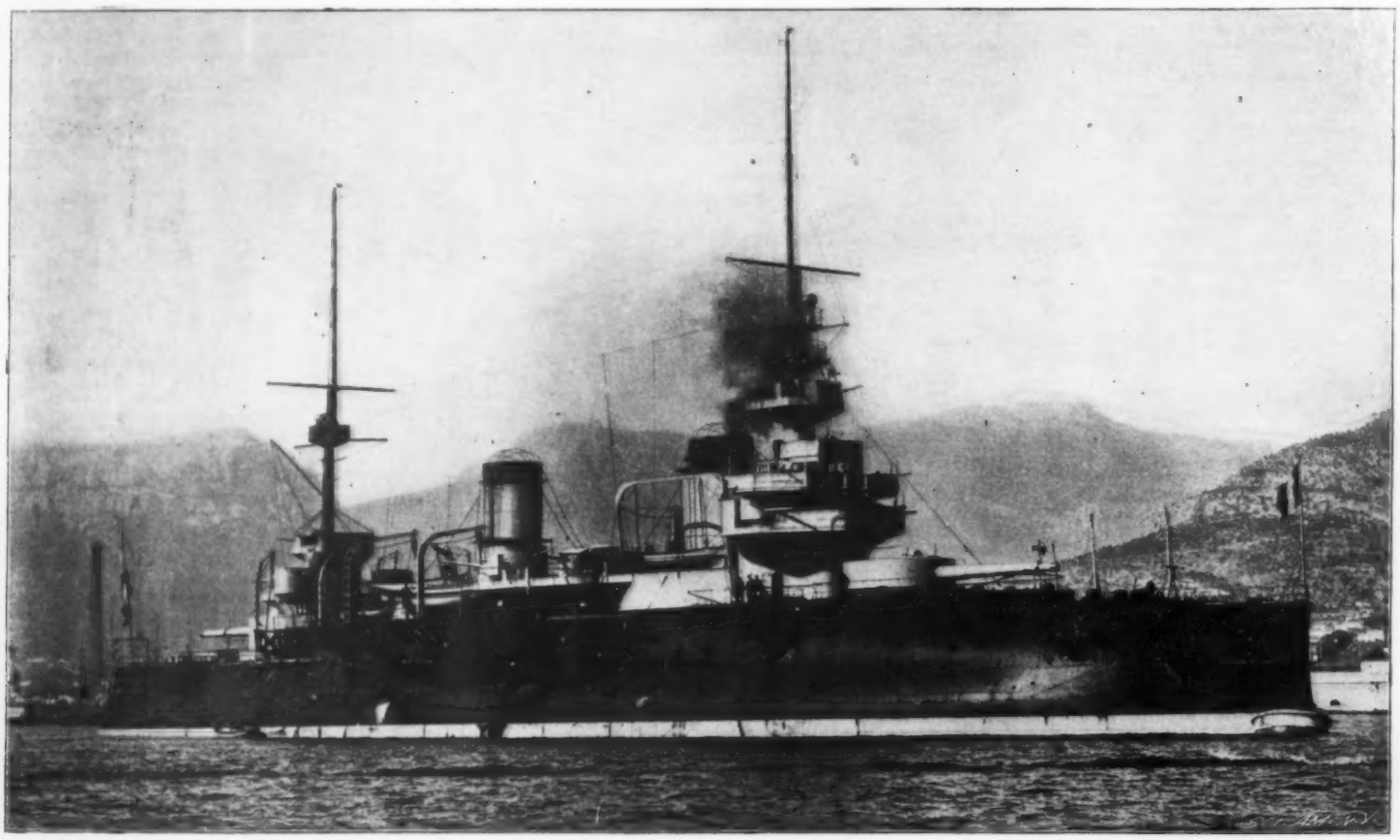
The "Hoche," 10,997 tons, 16 knots, is an older vessel, armed with two 13·4 inch, two 10·8-inch and eight 5·5-inch rapid-firing guns. There are also in the class of ships more than ten years old the "Magenta," "Marceau" and "Neptune," of 10,850 tons and 16¼ knots, armed with four 13·4-inch guns and a secondary battery of fourteen 5·5-inch rapid-firing guns. Older and inferior to these are the "Admiral Baudin," "Formidable" and "Admiral Duperré," vessels of 11,000 to 12,000 tons and 14 to 16 knots speed.

The coast defense vessels of the French Navy are very effective ships; the most formidable vessels of this class being in general from 6,000 to 7,000 tons displacement and 15 knots speed. They are well protected, and armed with two powerful breech-loading guns, carried is separate turrets. The most effective of this type is the "Henri IV.," recently completed, which is of 8,948 tons and 17 knots speed. She carries two 10·8-inch breech-loading guns in turrets, and a secondary battery of 5·5-inch rapid-firing guns. The front line in the coast defense fleet is occupied by vessels of the kind described above, and in addition to these, there is quite a fleet of ships from 1,800 to 5,000 tons displacement, vessels which, although they are older, are heavily armed and well protected.

In the class of armored cruisers the French Navy is particularly strong. Although she is not the most powerful or up-to-date, it is safe to say that the "Dupuy de Lome" is the best known vessel of its type in the world, being chiefly remarkable for the fact that she is the only vessel afloat which is completely clothed with armor. In the earlier armored cruisers the French mounted the guns in separate turrets, one gun to a turret, and disposed the turrets as widely as possible over the length and breadth of the ship. While the "Dupuy de Lome" was never duplicated, the later cruisers of the "Bruix" class are liberally armored, being provided with complete water-line belts of unusual depth. They have a speed of about 18½ knots and range from 5,000 to 6,000 tons. The French have under construction, or lately completed, a large number of vessels of this class of great power and speed, among which may be mentioned the "Jeanne d'Arc," of 11,270 tons and 23 knots speed, and six vessels of the "Dupetit Thouars" type, of 9,517 tons and 21 knots speed, and the "Desaix" type, of 7,700 tons and 21 knots speed.

In the protected cruiser class there are thirty-seven vessels of 15 knots speed and over. The largest of these is the "D'Entrecasteaux," 8,114 tons and 19 knots speed, while two others, the "Chateaurenault" and "Guichen," are a few hundred tons larger than the "Columbia," and of 23 knots speed. The armament of these two last vessels will be more powerful than that of the "Columbia," consisting as it will of two 6·4-inch, six 5·5-inch and ten 1·8-inch guns, all of which are of rapid-fire type. In protected cruisers of between 4,000 and 7,000 tons displacement, the French Navy possesses thirteen, of which the "Jean Bart," which was present in New York during the Columbus celebration, is one of the best representatives.

In the small cruisers and gunboat class the French Navy possesses forty-two vessels, which average about 1,000 tons displacement, and have an average speed of about 17 knots. The torpedo-boat fleet is, as we have seen, of enormous size, with a total of 324 vessels, while to these is to be added a fleet of thirteen submarine boats, of which four have been completed and nine are under construction. Of the practical value of the last mentioned vessels, it is too early to speak with any certainty. The French people are placing high hopes upon them, but it will require the test of actual conflict to prove whether the submarine boat is to form a permanent part of our modern navies.



From photograph by Symonds & Co., Portsmouth, England.

FIRST-CLASS BATTLESHIP "BOUVET." "CARNOT" CLASS OF FOUR SHIPS.

Displacement, 12,200 tons. **Speed,** 18 knots. **Normal Coal Supply,** 621 tons. **Armor:** Continuous belt, 15¾ to 8 inches; deck, 3½ inches; gun positions, 14½ inches. **Armament,** two 12-inch B. L. rifles, two 10·8-inch B. L. rifles, eight 5·5-inch rapid-fire, eight 3-inch rapid-fire, twelve 1·8-inch, and twenty 1·4-inch. **Torpedo Tubes,** 4. **Complement,** 631. **Date,** 1896.

THE FRENCH NAVY.

[Continued from Supplement, No. 1291, page 20697.]

AMERICAN ENGINEERING COMPETITION.*

XII.—MACHINE TOOLS.

The second of the New England machine-tool firms to which reference has formerly been made is that of the Brown & Sharpe Manufacturing Company, whose works are at Providence, in the State of Rhode Island. It is here that one finds the striving to approach accuracy as fully developed as anywhere in the world. If the spirit of Whitworth revisits this world, I think it must hover somewhere near. The physical manifestation of this spirit takes the form of micrometer gages, standard plugs, rings, and other measuring instruments made in these works, which are seen in many of the best engineering workshops, not only of America, but elsewhere. A long chapter could be written on the system of gaging work by means of hardened and ground steel pieces of "dead-true" dimensions—a matter English mechanical engineers would do well to study closely. It is the boast of some of the most advanced machine-shop managers that a foot-rule is never seen in the place. To give an elementary idea of the method of procedure, we will suppose it is needed to plane a given part of a machine, a bed-plate say, to an inch in thickness. The casting is fixed to the table of the planing machine, and beside it is placed a hardened and polished piece of steel known to be exactly an inch thick. The bed-plate having first been brought to approximately the required thickness, the bridge or adjustable cross-slide of the machine is lowered, and adjustment is made until the cutting tool just touches the steel gage piece. Such an operation can be carried out by any workman, and the piece is then necessarily planed to practically exact dimensions. The method is not new in principle, but in order to get its full advantage the measuring piece must be accurate within very close limits. To produce the gage an expensive plant is needed, and great care must be exercised in making. The little plain cube of steel appears costly beyond reason at first glance, but not so if one has to produce it within the prescribed limits of "tolerance." Other extensions of the system are found in rigid diameter gages, used in place of ordinary adjustable calipers, the use of the latter involving quite appreciable error unless in very careful and skilled hands, added to which much time is needed for adjustment. Plug and ring gages are better known.

A complete outfit of gages, etc., involves considerable outlay. The usual pair of calipers, and a foot-rule, costing next to nothing, will do nearly all the work; but they will do it so roughly, so much worse, that a machine shop following the old method can never hope to compete with one that adopts the new. It will be understood that there are makers of standard gages in England, the country where the principle had its birth, but I am not now writing of English works. I feel constrained to say, however, that in the United States the more enlightened and more accurate system is followed to a fuller extent than it is here. In engineering works with us one often sees a set of plug and ring gages treasured as if they were precious heirlooms not to be touched by hands profane. To be of use such things must be used, and used constantly. They should be in the hands of the workmen, available

* This series of articles on American Industries was written by an expert of The London Times, who made an extensive trip through this country in order to prepare the articles, the first of the series being published in the Supplement of July 21.

at a second's notice, not in a glass case in the works manager's office.

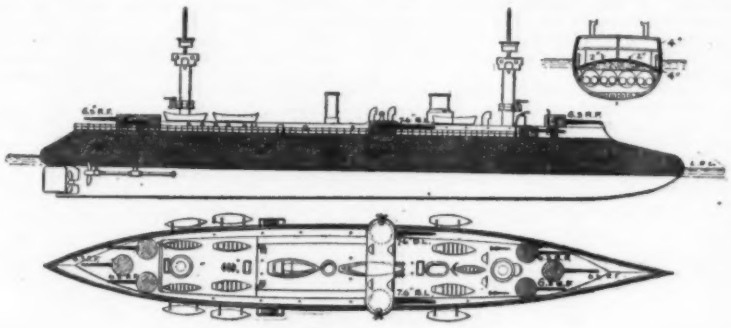
"But what an enormous outlay this means—thousands of pounds!" I think I hear a works manager say. Exactly; but think of the splendid return in labor saved and enhanced quality of work, higher selling prices, dividends, that would come from those thousands.

I wish the council of the Institution of Mechanical Engineers would pass a by-law that no one should be admitted to membership until he had visited a certain number of American workshops; or—as perhaps that would be somewhat too limiting—at any rate, that they would give more weight to such experience in judging fitness for full membership and associate membership. In view of the progress in America of bridge building methods and other constructive work, the same thing might be said in a modified degree of the Institution of Civil Engineers. We have suffered more in our engineering practice from stopping at home and thinking that what we do not know is not worth knowing than can well be imagined.

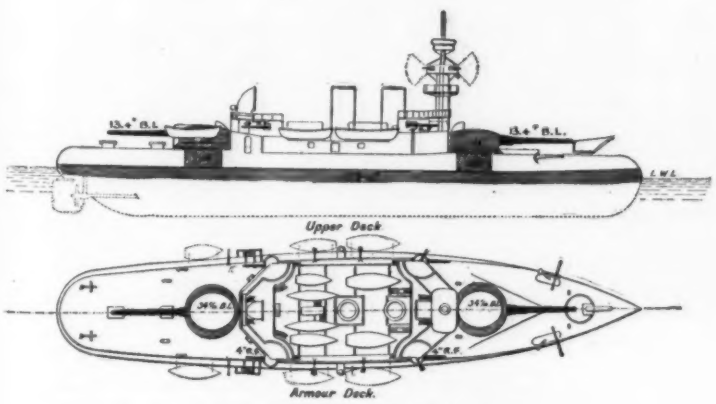
I say visit "American workshops" and not "foreign workshops," because it is true that in the United States there is incomparably more that is useful for us to learn in a given area than anywhere else in the world. Belgium has applied scientific principles to steam engine construction with common sense, and therefore with success; the Swiss are excellent engineers, especially in their utilization of water power for electric generation. France also is a useful country for the engineer to travel in, not only for the sake of learning how to do things, but also, in a limited degree, how not to do them. French designs are generally original, but too often smell of the lamp. The Germans are their direct opposite, and there is a good deal of sound commercial engineering in the country. They are practical, if slow. Not, however, slow to copy, and the discrimination they show in this respect has won for them a commercial success their common sense merits. I must do the Germans the justice to say, however, that there is in Berlin one of the most complete and best laid out machine-tool factories in the world. Its building up presents a valuable object-lesson to British tool makers. The works in question are those of Ludw. Loewe & Company, a firm which for twenty-five years past has made and sold machine tools, and has built up a large business, a good part of it in this country. Four years ago the Americans came strongly into the European market, as already stated, and the responsible managers of these works soon saw that they would have to meet a competition such as they had never before experienced. To do this, they wisely determined that the old crowded works in the center of Berlin—built up, like so many of our own, piecemeal on the accretion theory—would no longer serve. A large piece of new land was therefore secured on the outskirts of Berlin. The next two years were spent by the managers of the works in traveling in Europe and America, wherever engineering works were to be seen, for the sake of noting everything that was worth noting and adopting everything that was worth adopting. The result, I regret to say, is that the new works are entirely on American lines. English engineers who cannot afford the time to visit Berlin for the purpose of seeing these works can get a fair idea of the extent and completeness of them from an illustrated account which appeared in Engineering last autumn. I would, however, strongly advise all who can do so to go and see for themselves.

The remarkable development that has taken place of late years in the more westerly or middle States in the manufacture of machine tools is a matter that should not be overlooked. On the shores of Lake Erie, in the handsome city of Cleveland, Ohio, I spent a considerable time in the works of Warner & Swazey. This firm is, perhaps, best known as having made the famous telescope of the Lick Observatory, and they have always done quite an extensive business in instruments and outfits for astronomical purposes. I mention this more especially because the influence of the work is plainly to be seen throughout their productions. In connection with this question of the influence of subsidiary manufactures I might state that the Brown & Sharpe Company have for years past made the Willcox & Gibbs sewing machine, and, I understand, they attribute a good deal of their success as tool makers to this fact. To produce such a sewing machine as this, with delicate parts all interchangeable, compels accuracy in the appliances by which it is made. It is an ever-vigilant inspection officer overlooking the machine tool department, and, moreover, it has been fruitful in stimulating invention. In the same way the beautiful work needed for astronomical appliances has made its impress on the productions of Warner & Swazey in Cleveland. Perhaps an instance will best illustrate this point. In an underground room, carefully insulated against changes of temperature, is placed the dividing engine which is used for the more accurate work done here. It consists of a circular metal table having worm teeth cut in its periphery, and is caused to revolve by means of a worm which gears into the teeth. The object to be divided—it may be a meridian or a transit circle—is fastened to the table and a scribing point is caused to reciprocate so as to scratch the divisions on the metal circle. The circular motion of the table is intermittent, and it will be evident that, unless all the separate movements that take place between the marking of each line are of the same amplitude, the divisions will not be true. I believe this instrument is generally allowed to afford the nearest approach to accuracy in work of any yet made. The worm which turns the table is operated by a hydraulic motor which derives its movement from water at a constant head, so that the power exerted is unchanging. That in itself would be insufficient, for, if the pitch of the worm and of the teeth in the circumference of the table were not true, the divisions on the work would also be out of truth—that is to say, the approach to accuracy in the work produced depends on the similarity in distance of the movements of the table. In order to get as near absolute truth as was possible, the makers worked on the engine for 2½ years, at the end of which time they reduced the error of divisions to 1⅗ seconds of arc. That would have appeared to a good many people as near accuracy as ordinary human beings could hope to get; but the makers were not satisfied, and after another year's work they reduced the error to less than a second of arc, equal in distance to about one inch on a circle of three miles radius, or 1 in 1,198,702. In order to prevent expansion or contraction through change of temperature, the room is, as already stated, carefully insulated and kept at a uniform heat. It is said that the heat from the body of the attendant would produce quite an appreciable distortion in the table, and, therefore, for fine work care is taken that no one shall approach the machine. As all the movements are automatic, the usual mode of procedure is to leave the machine to do its duty and lock up the room. The dividing of transit and meridian circles needs the greatest accuracy, as they are used to fix the position of stars, and this can be accomplished, as stated, within a second of arc.

Naturally such super-refinement of accuracy is not needed in machine tool making, but it is a wonderful help to the shops, nevertheless. An instance may be taken of a tool for making gun-metal valves for water or steam. The parts are produced in automatic machines, and each part of any valve must fit the part of any other valve that is complementary to it with sufficient accuracy to make the whole steam or water tight. The usual way of making valves and cocks is to turn them on a lathe. For a shell this will need three chuckings and many operations on the part of a skilled turner. I saw globe valves turned from rough brass castings in one of the automatic machines. The part was taken and held in a revolving chuck or holder, both ends were bored, tapped (i. e., had an internal screw thread cut), and squared on the outside, and the part was bored and tapped to take the gland

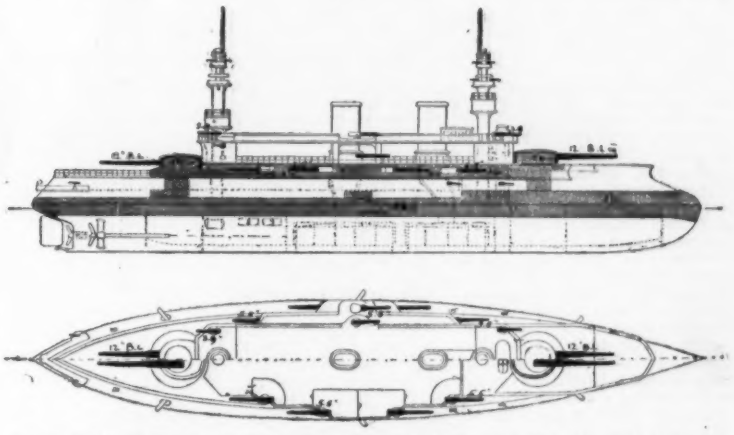


THE "DUPUY DE LOME."

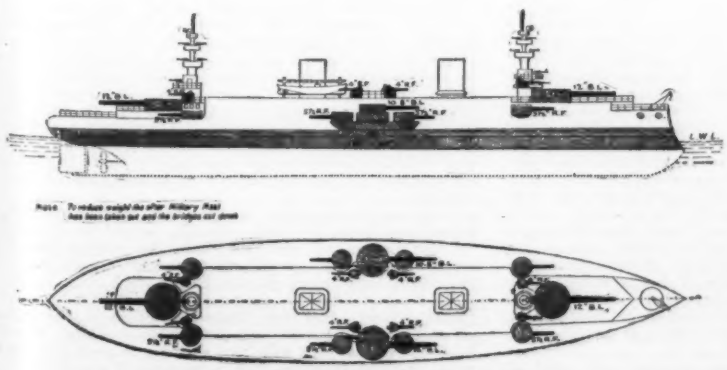


"VALMY" CLASS. FOUR SHIPS.

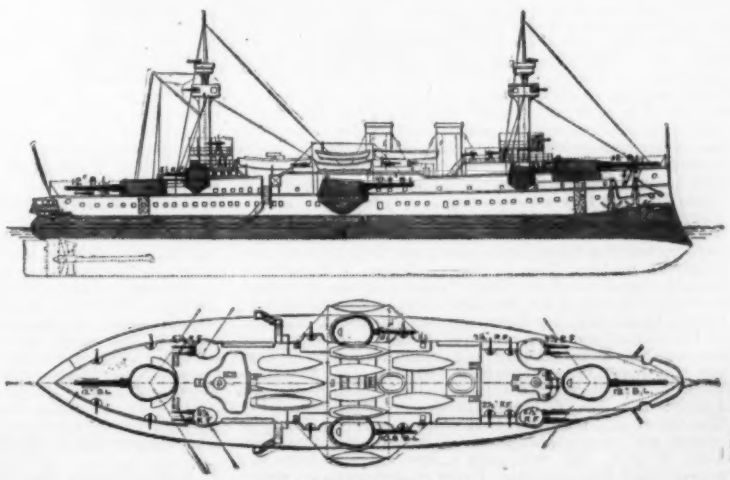
"Valmy" and "Tréhouart" have 13·4-inch guns in the turrets and four 3·9 inch guns. The "Bouvine" and "Jemmappes" have 12-inch guns in the turrets and eight 3·9-inch guns.



FIRST-CLASS BATTLESHIP "CHARLEMAGNE," 11,275 TONS, 18 KNOTS. CLASS OF THREE SHIPS. ALSO "IÉNA" AND "A 9," 12,052 TONS, 18 KNOTS.



"CARNOT" CLASS OF FOUR SHIPS.



THE "JAURÉGUIBERRY."

THE FRENCH NAVY.

which carries the stem. All this includes a large number of operations, and they were all performed by the machine in about one minute—the size was a 1-inch valve—so unerringly that no hand-work was needed, an ordinary unskilled attendant "minding" the machine. I do not think a highly skilled brass turner with an ordinary brass finisher's lathe would do the work in less than fifteen minutes; and even then the "human factor" would introduce an element of uncertainty that would render interchangeability very doubtful.

The view must not be adopted that these advanced machines are used only in the United States, for large numbers of them have been sent abroad from American workshops, and, indeed, there is one firm in England which, from small beginnings, has rapidly grown to a business of some importance and which is doing good work in producing machine tools on the same lines. But what is one firm against the many big works in America? They are turning out day after day, or often, one should say, day after night and night after day, labor-saving and profit-earning machines, mostly for home use. The difficulty in Great Britain remains, even if the organization existed for producing the tools, of getting them used. An actual example, which came before my notice three or four years ago, will illustrate this. A large firm of brass finishers in England, having seen the American automatic machines at work, decided to purchase some for their own use, and the order was actually placed. A few days after the managing partner came to the representative of the American house and begged to have the order canceled, offering to pay compensation, which, however, was not accepted. The reason for this change of policy turned out to be that the foreman, when consulted about the disposition of the new machinery, had warned the firm that the change would be so opposed by the men that labor troubles and consequent disorganization of business would result, and therefore the old hand methods continued.

In these circumstances it is hardly surprising to find that the American automatic machinery is being shipped to all parts of the world; and also that the American exports of manufactured brass, although still less than our own, are advancing year by year with rapid strides, while our own are declining. I saw at the Warner & Swazey works the last installment of a complete equipment of automatic machines for making steam valves. This plant was being shipped to Mexico for a works where copper is smelted and brass is made. The order included everything needed. There were complete sets of drawings of the most modern and approved forms of valves, patterns, machines, tools, fixtures, gages, flasks for casting, etc. The only thing that remained to be done in Mexico was to erect the machinery and set to work. Of course, one or two American workmen were being sent out to start operations, and for the rest the unskilled labor of the country will suffice. I do not know whether the Mexicans propose entering the foreign market. Probably the commercial organization is not sufficiently developed for that; but, if they do, the brass finishers of this country, highly skilled as they are, will not stand a ghost of a chance against the untrammeled and low-paid labor of Mexico, as applied to the highly-organized and beautifully-made tools that are going out from Cleveland, Ohio.

The great army of skilled mechanics in this country are considered a tower of industrial strength, but perhaps they may also prove a source of weakness; and here it may be pointed out that great manual dexterity by no means indicates a high state of civilization, but perhaps rather the reverse. The ivory carvings of China and even the flint implements of pre-historic man are instances in point. Before planing machines, milling machines, and emery grinders were invented, the mechanics who chipped surfaces with the chisel, and filed them smooth by hand, possessed a manual dexterity that seems to be fast disappearing. Rude as many of the early steam engines are to our eyes, it is doubtful whether they could be produced now with the appliances then in use. Any lad fresh from school can learn to attend a milling machine in a few hours, and will produce a surface that could hardly be excelled by a man with hand tools who had spent half a lifetime in acquiring manual dexterity. A great many English artisans who go out to the United States find the first thing they have to do is to forget they are "skilled mechanics." Some refuse to learn the lesson, and they either go to the wall or go home again. The majority, however, conform to the situation, and mould themselves to the new conditions in a manner they would never do in England. The man who has the sense to do this will generally rise, and then his wider knowledge stands him in good stead. His early training has been in shops where specialization is not carried to the extent it is in America. He is not a mere machine minder, and so it often comes about that he is chosen as foreman, because his more comprehensive knowledge enables him to exercise jurisdiction over a wider field.

On the other hand, I have found the majority of the most highly-skilled mechanics in America, such as are employed in the tool rooms, to be Americans native born, or at any rate educated in America. The reason for this it is difficult to give, but probably the superior education—to use the word in its widest sense—of the American workman enables him to think more closely, and to study how best to develop manual dexterity; for, after all, what we call manual dexterity is largely a matter of brain power.

In the heavy description of machine tools we have not yet experienced any competition of a very serious nature, but the American makers are now giving more attention to this class of work. When in Hamilton, Ohio, I visited the Niles Tool Works, and was surprised to find so extensive an establishment in this far inland town. Quite recently there has been an amalgamation, of the nature now so popular in America, of four large engineering firms making big machine tools. These are the Niles Works, Bement, Miles & Co., of Philadelphia, the Pond Machine Tool Company, of New Jersey, and the Philadelphia Engineering Company. The last named devote themselves largely to electric cranes and steam hammers. I visited only the Niles Tool Works, and will give a few extracts from my notes. The first machine I saw in progress, on entering the spacious and well-arranged shops—the largest is 400 feet by 400 feet—was a horizontal boring, milling and drilling machine, having a 10-foot bed, with a circular-revolving table. This was a very large and powerful tool, suitable for heavy marine work, and was to be erected in a marine engineering works in Holland. There were nine of these in progress at the time, the majority being for Europe. It was stated incidentally that about half the product of these works is to fulfill export orders, the foreign trade having increased largely of late. Next there was a set of steam-bending rolls, but these were for the American government. They would bend a plate 25 feet long and 1 inch thick. A vertical boring mill was 16 feet between the housings and would take work 8 feet high under the bridge on which the saddles traverse. There were no fewer than fourteen of these big machines in hand. Two of these were arranged so that the columns and bridge they support would slide back on the bed. In this way work 24 feet in diameter could be dealt with on the revolving tables, the latter being designed to take work up to 150 tons weight and having spindles 24 inches in diameter. A big planing machine would operate on pieces 13 feet square and take a cut 30 feet long. Two of these were in progress for Germany, and a large firm of Sheffield steel-makers have also two of these planers at work.

Next there was a 90 inch locomotive wheel lathe in progress; then two car wheel presses, one of 400 tons and one of 500 tons; there being also twelve 200 ton presses in hand. Three heavy slotting machines came next, each having a 24-inch stroke. One of these was for America and one for Honolulu, which seems a strange destination for so large a machine. There had recently been supplied to a Sheffield firm two big slotting machines, and two more had just been dispatched to France. It would be wearisome to continue a catalogue of the machines in progress, but perhaps enough has been said to show that big tools can be made in the United States to be sold abroad. Whether the business is likely to increase is a matter on which opinion may be divided. I can only say the American makers express themselves confident of being able, when the occasion arises by the slackening of home demand, to meet competition in any part of the world, not excepting Great Britain. The designs of the large American machine tools are not by any means copies of our own, except so far as the origin of most heavy machines is British. There are a good many features about them which at once denote independent thought. In regard to undue lightness, an accusation often brought against American work, there is certainly an impression given of this nature when some of the machines—I am thinking especially of the planing machines—are looked at end on, but a side view gives quite a different impression. In other words, the metal is disposed to give rigidity more particularly in a longitudinal direction, and it is longitudinal stresses that chiefly have to be met. There are, of course, other equally important firms in the United States that are making heavy tools and bidding for export orders. In meeting them in neutral markets British manufacturers will have the advantage of being more within their own peculiar province, but there can be little doubt, whoever gets the bulk of the trade, that American makers will be foemen well worthy of our steel.

It is probable that American capital will build an underground railway of 6½ miles in length from Charing Cross to Hampstead, London.

THE WESTINGHOUSE GAS ENGINES.

Doubtless everyone who has had occasion to investigate the respective merits of the various gas engines offered to the public has been impressed with the fact that manufacturers, almost without exception, are exceedingly chary of giving out any information as to mechanical construction, or any detailed explanation as to the functions of the different parts and their relation to each other.

A collection of modern steam engine catalogues contains more real practical information than the best text-books on the subject, while the perusal of a number of gas engine circulars would tend to create in the mind of the reader an impression that what goes on between the valve on the gas supply pipe and the belt of the driving pulley is a trade secret which must under no circumstances be divulged.

It is the belief that many people hesitate to purchase because they feel that it is a complicated and delicate machine which only an expert can understand, and that in the event of failure or misadjustment of any part they will be helpless. We are doubly sure that this seeming policy of secrecy is responsible for the greater part of the difficulties and disappointments experienced by users.

When the location and appearance of the different parts are understood, and the duty which each has to perform is made plain, it will be seen that the gas engine is fully as simple a machine as the steam engine.

While information of this nature is public property, obtainable from text books, few have the time or the inclination to sift it out from the mass of unnecessary information contained therein, and we therefore append a brief, and we trust lucid, explanation of the matter as particularly exemplified in these engines.

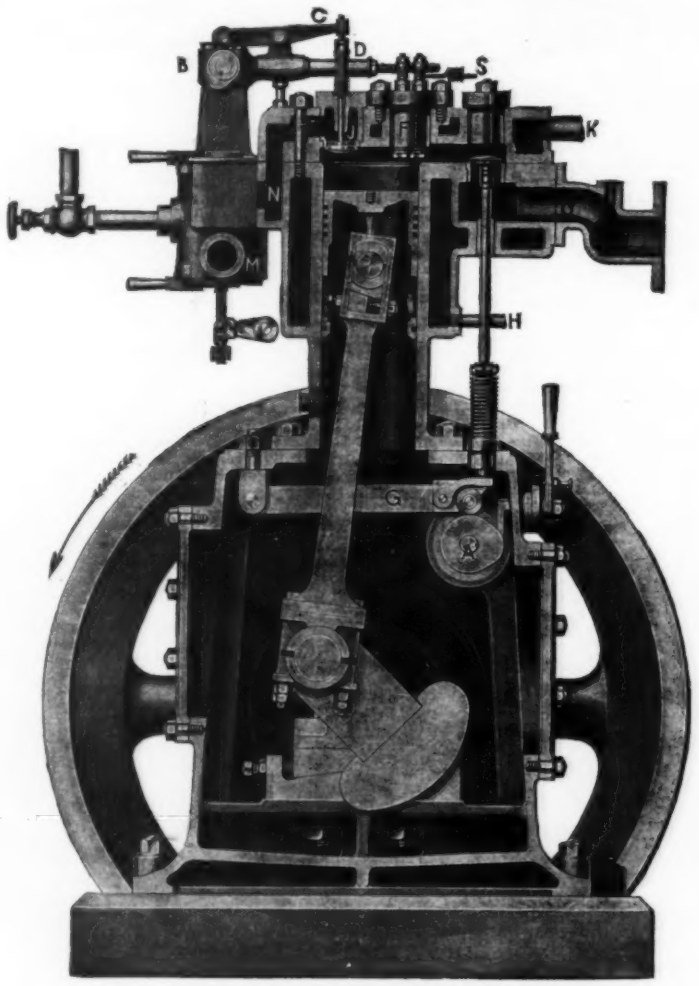


Fig. 1.—CROSS SECTION THROUGH CYLINDER.

The engraving, Fig. 1, shows a section through one cylinder of the three-cylinder engine, all three being exactly alike. The illustration and description will apply with sufficient accuracy to the two-cylinder engine as well, although the mechanism for actuating the inlet valves and igniters is somewhat differently disposed in the latter.

The cylinders are mounted on an inclosed crank case, the distinguishing feature of the Westinghouse single-acting steam engines, which forms the base or frame of the engine, and serves as a receptacle for the oil which lubricates the cranks and upper journals of the connecting rod. The engine is single-acting, a feature which we have always regarded as desirable in a steam engine, but which is absolutely necessary in a gas engine, for the reason that stuffing boxes and piston rods deteriorate too rapidly when the latter are exposed for half the time to an atmosphere of burning gases.

A simple trunk piston of generous length, carrying a hardened steel wrist pin, which is linked to the crank by the connecting rod, comprises the mechanism for transforming the intermittent pressures on the top of the piston into rotary motion at the shaft.

The feature about a gas engine which gives an impression that it is a complicated machine is the train of gearing used for driving the valve motion. When it is understood just why this gearing is required, and what purpose it serves, the impression of complication disappears, as gearing in itself is one of the oldest and most familiar elements of machinery. In order to

make the utility of the train of gears apparent, it is necessary to consider what takes place in the cylinder. As the gas must burn in the inclosed space between the piston and the cylinder head, it must first be mixed with such an amount of air as will furnish sufficient oxygen for its rapid and complete combustion. If the air supply be too little, the gas is not all consumed, and the economy is thereby seriously impaired, and if the air supply be too great, the quantity of gas used per stroke is reduced, resulting in lowering the capacity of the engine.

The piston being at the top of its stroke and moving downward, draws in a cylinder full of the mixture of gas and air. On the return stroke this charge is compressed into the clearance space between the top of the piston and the cylinder head. The smaller this clearance, and consequently the higher the compression, the more efficient the engine, the reason being that with a measured quantity of gas, such as is contained in a cylinder full of the mixture, the smaller the space in which it is burned the higher will be the pressure generated, and the smaller the initial volume of the products of combustion under the high pressure, the greater number of times they will be expanded in following up the piston to the end of its working stroke.

A high initial pressure coupled with a large ratio of expansion has a more important effect on the economy of a gas engine than of a steam engine, because in the former we do not have to contend with the phenomenon of cylinder condensation, which in the latter offsets the gain from expansion when carried beyond certain limits.

While there is no theoretical limit to the extent to which compression might be carried with corresponding increased efficiency resulting, there is a practical limit at which we must stop, for the reason that when this is passed the heat generated by compression will cause the mixture of gas and air to ignite spontaneously. This would be fatal to the operation of the engine, as in order to secure good results we must be able to control the ignition and time it accurately, having it occur just as the piston is ready to begin the next succeeding downward stroke.

Premature and spontaneous ignitions cause pounding, reduction of speed and power, and may even cause a complete stoppage.

The piston having reached the top of its compression stroke, the charge is ignited by the spark formed by opening an electric circuit in the clearance space. The air and gas being thoroughly mingled in the right proportions, combustion takes place with such rapidity that it may properly be called explosion, and the resulting heat raises the pressure to several hundred pounds to the square inch. The burnt gases under this high pressure expand, driving the piston downward on its working stroke, and are expelled through the exhaust on the return stroke, which when completed brings all the parts of the engine in position to repeat the same cycle of operations. All gas engines that have achieved any marked degree of success operate on the plan outlined above, which was first proposed and was patented in France in 1862 by M. Beau de Rochas, although the fruits of the invention, as well as the credit of it, were so promptly and completely appropriated by others that the real inventor has been well nigh forgotten.

From the general explanation of the cycle of operations occurring in the engine, it will be seen that during one revolution it acts as a pump to supply itself with fuel, which it utilizes running as a single-acting pressure motor during the next succeeding revolution. The valves and the igniters pertaining to each cylinder have therefore to perform their functions once for every two revolutions of the crank, instead of once for every revolution, as in the steam engine, consequently the cams which operate these parts—cams being used in preference to eccentrics by reason of their more prompt action—must be mounted on shafts running only half as fast as the main shaft, and a train of gears is the only positive means by which this reduction of speed can be made, and this is the sole object for its introduction.

Referring to the sectional cut, Fig. 1, *A* is the shaft which carries the exhaust valve cams, and is driven by gears from the main shaft. Each exhaust cam works against a roller carried on the free end of the guide lever, *G*. The exhaust valve, *E*, has a long stem projecting downward and resting on a hardened steel plate on the upper side of the guide lever, *G*. The spring surrounding the stem serves to hold the exhaust valve to its seat and the stem in contact with the guide lever. From the exhaust cam shaft, *A*, a horizontal shaft with bevel gears leads to the opposite side of the engine, engaging with a vertical shaft which in turn drives the upper cam shaft, *B*. Incidentally, the vertical shaft carries the governor. The upper cam shaft carries two cams for each cylinder. One engages against a roller on the end of the horizontal lever, *C*. As the throw side of this cam comes uppermost, the opposite end of the lever, *C*, depresses the stem of the inlet valve, *J*, opening the latter for the admission of the mixture of gas and air. A spring on the stem of the inlet valve furnishes a means for closing it and keeping the cam and roller always in contact with each other. Immediately adjacent to the inlet valve cam is the igniter cam, which at the proper instant operates a horizontal plunger working through the guide, *D*, to break the electric current through the wire, *S*, at the terminals of the igniter, *F*.

The cylinder heads and the upper end of the cylinder are thoroughly water-jacketed, as, owing to the extreme heat to which these parts are subjected, they would soon become red-hot if no means were provided for keeping the temperature down. The cooling water enters at *H* and is discharged at *K*.

The sectional cuts, Figs. 2, 3, 4, and 5, will illustrate more clearly the four parts of the complete cycle of operations, as the details of the cylinder and valve gear on a somewhat larger scale, and the relative positions of the valves, etc., are shown separately for each part of the cycle. The reference letters are the same as in the complete section, Fig. 1.

The gas and air enter the mixing valve chamber, *M*, by separate inlets, in proportionate amounts which can be fixed by the attendant, and the mixture is conducted

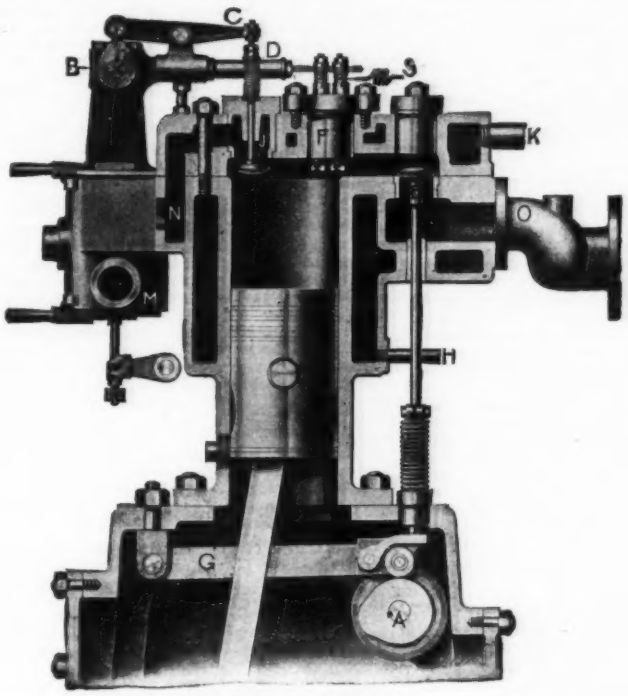


FIG. 2.—CHARGING STROKE.

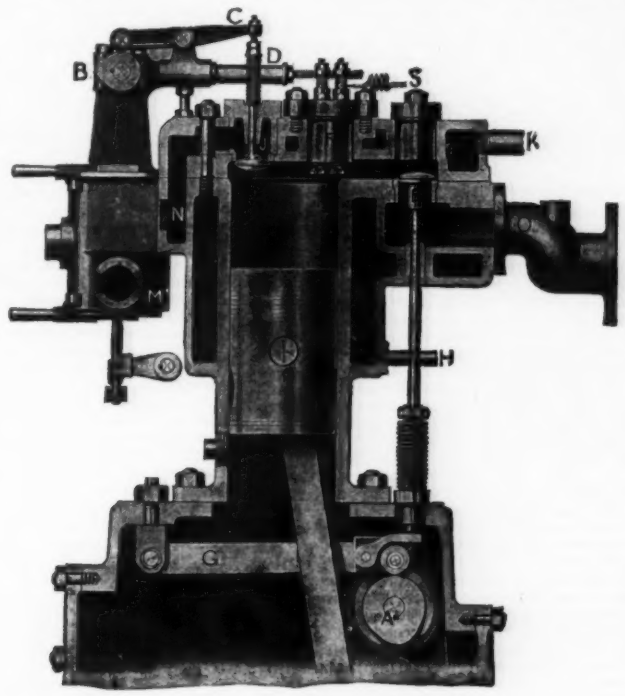


FIG. 3.—COMPRESSION STROKE.

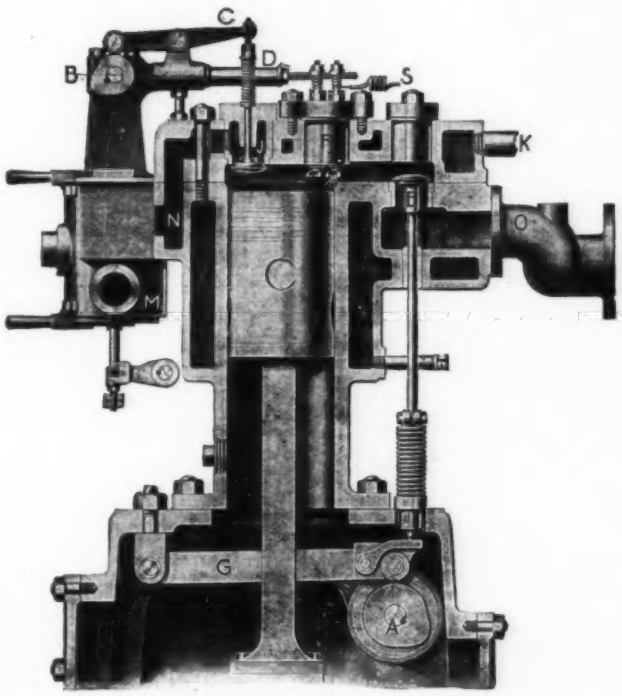


FIG. 4.—IGNITION.

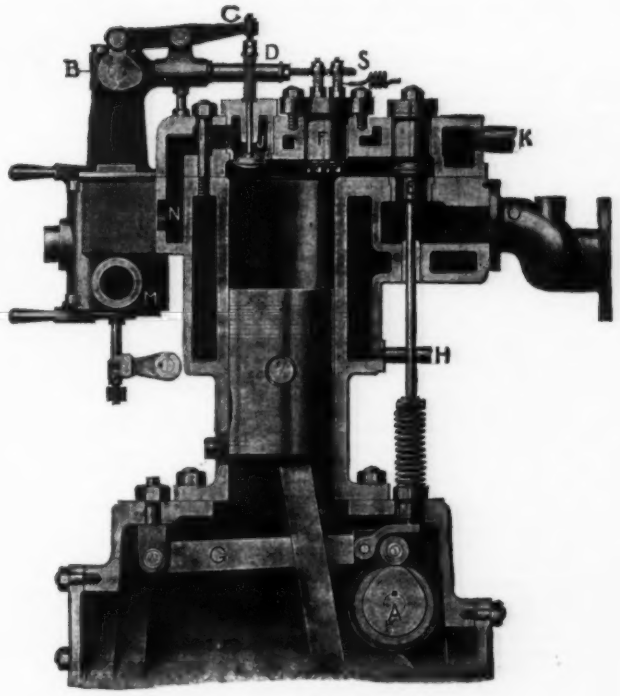


FIG. 5.—EXHAUST STROKE.

through a distributing chamber to the port, *N*, leading to the cylinder head in which the inlet valve is located.

In the induction position, Fig. 2, the piston is on its downward stroke, the inlet valve, *J*, is open, and the charge of gas and air is being drawn into the cylinder. The exhaust valve, *E*, is closed, and the inlet valve will close just as the piston reaches the limit of its downward stroke.

In the compression position, Fig. 3, the piston is on its upward stroke, both valves are closed, and the charge of gas and air is being compressed into the clearance space.

In the ignition position, Fig. 4, the piston has reached the upward limit of its compression stroke, the crank is just passing its upper center, and both valves are still closed. Shortly before this the igniter cam has brought the igniter terminals in contact, completing an electric circuit. Just at this instant it releases them, and they fly apart, actuated by a coiled spring located in the guide, *D*, breaking the circuit and forming a spark which ignites the charge. An immediate rise of pressure occurs, and the piston is forced downward by the expansion of the burnt gases, both valves remaining closed until just before the completion of the stroke, when the exhaust valve, *E*, opens.

In the exhaust position, Fig. 5, the piston is ascending, forcing out the spent gases through the now open exhaust valve, *E*, and the exhaust pipe, *O*. The exhaust valve closes as the piston completes the stroke, bringing everything in readiness to repeat the cycle.

WIRELESS TELEPHONY.*

The first experiments in this direction were made in the month of February, 1894, across Loch Ness in the Highlands. On that occasion trials were made to determine the laws governing the transmission of Morse signals by electromagnetic method of wireless telegraphy, which has formed the subject of frequent reports to this section since 1884; two parallel wires well earthed were taken, one on each side of the lake, and arrangements were made by means of which the wires could be systematically shortened, with a view of ascertaining the minimum length necessary to record satisfactory signals. It occurred to Mr. Gavey, who was experimenting, to compare telephonic with telegraphic signals, i. e., to ascertain whether articulate speech could be maintained under the same conditions as Morse signaling. The trials showed that it was possible to exchange speech across the Loch at an average distance of 1·3 mile between the parallel wires when the length of the wires themselves was reduced to four miles on each side of the water.

What led to this train of thought was the fact that although the volume of telegraphic current was immensely greater than that of a telephonic current, whenever, through want of balance in a loop, disturbance was evident, then telephonic cross-talk was also manifest. In other words, a weak telephonic current was apparently as powerful a disturber as a strong telegraphic one.

The sensation created in 1897 by Mr. Marconi's application of Hertzian waves distracted attention from the more practical and older method. Mr. Evershed and Prof. Oliver Lodge had, in the meantime, much advanced the system by introducing admirable call systems.

In 1899 the author conducted some careful experiments on the Menai Straits which principle determined the fact that the maximum effects are produced when the parallel wires are terminated by earth plates in the sea itself. It became quite evident that the ordinary inductive effects are much enhanced by conductive effects through the water, and that in consequence shorter wires are practical. No special apparatus seems necessary, and the ordinary telephonic transmitters and receivers were used.

It became desirable to establish communication between the islands or rocks known as the Skerries and the mainland of Anglesea, and it was determined to do this by means of wireless telephony. The lighthouse at the Skerries was wanted to be in communication with the coast guard station at Cemlyn. A wire 750 yards in length was erected along the Skerries, and on the mainland one of three and a half miles from a point opposite the Skerries to Cemlyn. Each line terminates by an earth plate into the sea. The average distance between the parallel portions of the two wires is 2·8 miles. Telephonic communication is readily maintained and the service is a good one.

Further experiments with wireless telephony have recently been made between Rathlin Island, on the north coast of Ireland, and the mainland. The east and west portions of the island of Rathlin are about eight miles from the mainland, but a tongue of land projects southward to within a distance of four miles. Communication was required between the lighthouse near the northeastern corner of the island and the mainland, and the question for solution was whether an overhead line running the whole length of the island from east to west was necessary to obtain good communication, or whether a shorter line across the neck of the southern peninsula would serve. The preliminary experiments that have been made prove conclusively that communication, both telegraphic and telephonic, has been readily maintained by means of temporary wires established across the neck of the peninsula along the shorter line. Wireless telegraphy across the sea is now a practical and commercial system.

No experiments have yet been made with ships, but it would appear simple to speak by telephone between ship and ship or between ship and shore to considerable distances by means of a circuit formed of copper wire terminating at each end of the ship in the sea, passing over the top-masts and using simple telephones.

WARM WATER TO DETERMINE SENSITIVENESS TO HEAT.

Since it has been discovered that the nerves of temperature are distinct from those that transmit ordinary tactile sensations, many tests of the sensitiveness of these nerves in different parts of the body have been made by physiologists. It is important, of course, to make these tests in such a way that an ordinary sensation of touch shall not be confounded with a sensation of heat or cold. Two French experimenters, Messrs. Toulouse and Vaschide, have recently constructed what they name a "thermoesthesiometer," in which drops of warm water are employed to test the sensitiveness of the body to heat. An account of this instrument was read on January 22 before the Paris Academy of Sciences. Says Cosmos (February 3) in its report: "A good thermoesthesiometer should be practically without weight, should be able to test small surfaces for the determination of hot and cold points, and should be inoffensive. Warm water, in the form of drops, fulfills all these conditions. When we let fall from an average height of one centimeter [about half an inch] on a point of the skin, a drop of distilled water weighing less than one-tenth of a gramme [1½ grains] and heated to a temperature near that of the subject's skin, the latter will feel no sensation of contact. Consequently, if a drop of water of the same weight, but hotter or colder, is felt by the subject, it must be on account of its thermic qualities alone. Boiling water can not be hotter than 100° C. Now, a drop of water one-tenth gramme in weight, taken from a mass of boiling water, gives a sharp sensation of pain, but does no injury whatever. It is on these principles that Messrs. E. Toulouse and N. Vaschide have made a thermoesthesiometer, composed essentially of a drop-counting bottle filled with distilled water and furnished with a thermometer."—Translation made for The Literary Digest.

* Abstract of a paper read by Sir William Henry Preece, K.C.B., F.R.S., before Section A of the British Association at Bradford.—Journal of the Society of Arts.

A CURIOUS CLOCK.

We illustrate herewith, from La Nature, a curious clock manufactured by a M. Passerat and exhibited by him at the Exposition.

Upon a square wooden base, decorated with bronze ornaments, is placed a tin plate of ordinary size. Externally, nothing seems to indicate that any relation whatever exists between the plate and its support. The sole relation between the two objects is an almost invisible reference point that permits of laying the plate always at exactly the same place upon the pedestal.

The edge of the plate is provided with divisions like those of the face of a clock. If water be poured into the plate and a small duck be placed therein, we shall immediately see the latter take a fixed direction and indicate the hour with the extremity of its bill. Upon leaving the apparatus at rest, we shall see the bird move slowly, as the hand of a clock would do, and point out the different hours as they occur.

The mechanism is easy to understand. In the interior of the base there is a clockwork movement that actuates a vertical pivot upon which is fixed a balanced horizontal arm. At one extremity of this is placed a powerful magnet. The system is so regulated that the horizontal arm makes one complete revolution in twelve hours. On another hand, the bill of the duck is made of soft iron and the magnet attracts this through the tin plate. As tin is not sensitive to magnetization, it behaves as a neutral body, so that the duck alone undergoes the magnetic influence. It accompanies the magnet in its travel and consequently marks the hours on the divisions of the plate.

A CURIOUS CLOCK.

ANTIQUITY OF AGRICULTURE.

"The origin of agriculture," says Prof. A. C. Haddon in Knowledge, "is lost in the mists of antiquity. We know that in Neolithic times in Europe, eight kinds of cereals were cultivated, besides flax, peas, poppies, apples, pears, bullace-plums, etc.; at the same time, various animals were domesticated. Among these were horses, short-horned oxen, horned sheep, goats, two breeds of pigs, and dogs. Prof. W. Boyd Dawkins says that evidence goes to show that these animals were not domesticated in Europe, but probably in the central plateau of Asia. He also thinks that agriculture arose in the south and east of Europe and spread gradually to the center, north, and west. A hunting population is often very averse to even the slight amount of work that agriculture requires in a tropical country. The same holds good, as a rule, for pastoral communities. In all cases a powerful constraint is necessary to force these people into uncongenial employment. Fate is stronger than will, and at various periods, in different climes, hunters and herders have been forced to till the soil." This, about the means of transport across the deserts, is interesting: "The desert, notwithstanding all difficulties of communication, offered more facilities than the sea to early man; it had, in fact, three manifest advantages over the Mediterranean: 1. The desert penetrates further into the interior of the countries. It is several times larger than the Mediterranean, and therefore can tap more countries; it reaches to precisely those richest countries that the Mediterranean does not touch. 2. The desert does not oblige the pastor to seriously modify his mode of life. In order to traverse the desert it is certainly necessary to arrange the journey in stages, but these stages once created, the pastor can live his old life. 3. A numerous troop can cross the desert. They travel in caravans for greater safety and defense against possible attacks. . . . Such are the reasons which caused early man to travel over the desert before voyaging over and utilizing the sea."

TRADE NOTES AND RECEIPTS.

To Protect Iron against the disadvantageous action of acid vapors the use of gutta percha varnish is recommended. Same is produced as follows: Melt 1 part of gutta percha shreds together with double the quantity of purified pale colophony and stir turpentine-oil into the mixture. Zinc white may still be added.—Praktischer Wegweiser.

To Revive Leather Furniture.—Methylic alcohol 45 liters, thin resin oil 22½ liters, vinegar 22½ liters, hard glazing 11¼ liters, butter of antimony 3·855 kilos.

Mix the ingredients thoroughly and fill in bottles. The mass may be used for regenerating the leather as well as the polished wood. It is applied with a clean rag and rubbed with another one.—Seifensieder Zeitung.

Production of Very Fine Carbolineum.—Dissolve completely and uniformly in an iron kettle 100 kilogrammes of anthracene oil and 10 kilogrammes of dark American resin at a moderate heat. Next add 1 to 2 kilogrammes of a gum or coutchouc solution, according to the desired covering power of the carbolineum, and keep on boiling until all has dissolved. When this is done, add 5 kilogrammes of crude carbolic acid, 100 per cent., stir well, and put the finished carbolineum into barrels to clarify.

A coating with this carbolineum is deep brown, very durable and preserves lumber of all kind, constantly exposed to moisture, such as miners' truck, throughout.—Seifensieder Zeitung.

The Calcium Carbide Industry in Europe.—Exact data are now at hand on the development of the calcium carbide industry in Europe, which show that the production has increased considerably during the last year. The total capacity of the French carbide works is 50,000 horse power, furnished by water power. Germany operates with 12,440. Italy with 16,000 horse power. In England only 1,600 horse power are at the disposal of the carbide industry. Mountainous Norway abounding in water disposes 15,000. Austria 18,550 horse power. Russia's less developed industry is content with 3,500 horse power, of which only about 2,000 is supplied by water power. Switzerland at present works with 19,000 horse power, but it is probable that this industry will make especially large progress in that country. France, by the way, does not work full force either, since its actual output is still below 20,000 tons, while she could easily produce 27,000 per annum.—Technische Notizen.

Corks with a Copper Coating.—In the manufacture of sparkling wine, not only the product requires a careful treatment, but also the storing, bottling, packing, etc., are sources of much inconvenience. Thus the corking of the bottles containing the carbonic acid presents no little difficulty, mostly owing to the porosity of the corks. Time and again the gas is found to have escaped during the storing, no matter how good the cork is. To this must be added the high price of 8 to 16 pfennigs (2 to 4 cents) apiece, which has to be paid for good champagne corks.

One of the most interesting ideas in this field does not discard the cork entirely, but reinforces it by a metallic armor, thus rendering it entirely impermeable. The filled and corked bottles are hung, neck down, into a copper solution, and by means of the electric current a fine copper coating is precipitated on the cork, which is rendered conductive, and the mouth of the bottle the copper entering into the finest pores of the cork prevents most effectively any escape of carbonic acid. The copper deposit may now be given any desired coloring, by electro-silvering or gilding.—Zeitschrift für die gesammte Kohlensäure-Industrie.

Hemp-seed Oil Varnishes.—A. Lidoff has analyzed two hemp-seed oil varnishes of good quality.

The following table gives the results of the examination, as well as the constants of an unchanged hemp-seed oil:

	Varnish No. 1.	Varnish No. 2.	Unchanged hemp-seed oil.
Saponification number	201	....	194
Iodine number	140	....	143
Percentage of glycerine	5·24	....	10·89
Insoluble fatty acids (Hehner's number)	93·4	93·9	....
Acid number of the insoluble fatty acids	148·6	152·8	199·4
Ratio of the solid insoluble fatty acids to the liquid ones	95·2 per cent. liquid 4·8 per cent. solid		
Iodine number of the insoluble fatty acids	149·1	153·4	123 to 125
Acid number	13·1	12·7	..
Acetyl number	38·8	....	7·5

Besides, Lidoff conducted drying tests with one of the examined hemp-seed oil varnishes on the one hand and with the insoluble fatty acids separated from it on the other hand. The substance was spread on watch crystals and exposed, between funnels fastened in stands and which were about 5 centimeters from the rim of the watch glasses, to the action of the air at the sunny side of the window. The tests were carried out from end of August to beginning of September. From time to time the glasses were weighed.

Following are the results of the experiment:

Hemp-seed Oil Varnish No. 1.

Substance employed 4·407 grammes

Increase in weight after	18 hours	80 milligrammes	= 1·81	per cent.
" " " " further	24 "	16 "	= 0·36	"
Now the varnish became covered with a skin.				
Increase in weight after further	24 hours	2 milligrammes	= 0·04	per cent.
" " " "	72 "	none	none	
" " " "	48 "	3 milligrammes	= 0·07	per cent.
" " " "	168 "	23 "	= 0·52	"
Total after 354	"		2·80	"

Separated Fatty Acids.

Substance employed 6·273 grammes

Decrease in weight after	18 hours	33 milligrammes	= 0·52	per cent.
Increase " " further	24 "	7 "	= 0·11	"
" " " "	24 "	14 "	= 0·23	"
" " " "	72 "	56 "	= 0·89	"
" " " "	48 "	82 "	= 1·31	"
" " " "	168 "	78 "	= 1·24	"
Total after 354	"	Increase in weight	3·25	"

A skin was only formed after another 72 hours, hence after altogether 426 hours.—Russian Review of the Grease Industry, 1900, No. 38.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Depression in European Textile Industries.—As a whole the manufacturing business of Europe seems to have entered on a period of severe depression. The causes are such, however, as to permit the belief that its duration will not be very great.

Reports from Bradford and other textile centers of England state that factories have generally been forced to reduce their product on account of scarcity of orders. In one instance, thirteen cotton-spinning concerns, with over a million spindles, recently resolved to suspend operation for two weeks, to check the overstocking of the markets with unsalable goods. Doubt is expressed whether this temporary suspension will be sufficient to appreciably relieve the situation. The disturbance in China is assigned as a partial cause of the manufacturing depression in the British Isles.

From many parts of Germany come reports of stagnation in manufacturing industries, more expecially in textile branches. Rhenish Prussian factories and those in some districts of Saxony seem to be most affected. Thousand of looms and spindles are idle.

As indicating in some degree the extent to which the German textile industry has lost ground this year, it is published that in the first six months of 1900, the imports of wool into Germany declined 20 per cent. in quantity, and 45 per cent. in value, as compared with the corresponding period of 1899. The loss in business is slightly mitigated by the receipt at various Saxon textile factories of large orders for under-clothing for German soldiers destined to China.

The Chinese imbroglio is charged with but little share in the causes of the German industrial depression. German textile exports to the Orient have been too small for their utter extinction to account in any marked degree for the present contraction of business. The cause is generally assigned to the universally discouraging state of the textile markets, due mainly to over-production during the prosperous season of 1899.

The future looks sufficiently dubious to deter anyone from venturing at present into large contracts of any sort.

In Polish Russia, the production of the textile factories has decreased 70 per cent. this year in comparison with 1899. Some large firms have failed, with disastrous consequences to creditors. No causes are stated in the current reports from that country.

In Austria there is just now much complaint in textile circles, but the situation is better than in other parts of Europe, if reports are unexaggerated. In the direction of the United States, the linen trade of Bohemia is unusually large, the value of exports thus far this year showing an increase of 30 per cent. in comparison with the corresponding period of 1899. As a whole, however, the textile business of the empire is unsatisfactory at present, the causes named being the South African and Chinese wars and overproduction. But it is admitted that the situation must be worse before it equals that of some other European countries. Last year was a remarkably prosperous season for the Austrian textile industries. Previously, dull times had closed some factories, leaving to the survivors a larger volume of business than usual. The prosperity of 1899 caused new factories to be projected, but so far they have not served, by dividing orders in this duller year, to disastrously affect the older concerns. Prices of all kinds of Austrian textile products have been increased during the past year; and though a part of this increase has gone to pay the enhanced cost of raw material, on the whole the manufacturers have been much strengthened by the higher prices of their products.

With the unsettled state of the government as an ever-present disturbing factor, it is surprising that trade conditions in Austria should be even as good as those of other European countries at this time, instead of being rather better, as they apparently are.—Frank W. Mahin, Consul at Reichenberg.

Opening for American Folding Beds in South Germany.—A careful study of the domestic conditions of South Germany reveals the fact that American manufacturers of folding beds have made no successful effort to introduce them into this country.

A conference with German tradesmen who have lived for years in the United States and England sustains my own opinion that folding beds at low prices, simply made, would find a ready market here. There would probably be a larger call for single than for double beds. They should be devoid of expensive ornamentation, and care should be taken to have the designs free from carving, as there is a heavy duty thereon, the government refusing to make any distinction between hand and machine work. The mirrors should be supplied here as well as castors, weights, etc., that make expensive freights, and can be furnished here as advantageously as at home.

There are exports dealers in Munich who are ready to make a market for folding beds in South Germany, but it would be necessary to supply models.

So far as this office knows, the only folding beds in use here are iron frames folding into small settees and bed, and ordinary iron bedsteads for servants. With such articles I cannot hope to see American goods compete successfully, but the luxurious American folding bed need only to be shown to be appreciated.

There ought to be a ready market for folding beds combined with bookcases or wardrobes, especially the latter, as German homes are not supplied with closets, but are wholly dependent on wardrobes. The introduction of the simpler sort might ultimately open up a market for our expensive styles.—James H. Worman, Consul at Munich.

Critical Situation in British Iron Trade.—The Birmingham Daily Post summarizes the iron situation in this country, and in the Midland district particularly, in the following editorial:

In view of the present critical situation of the iron trade, caused by the collapse of demand on one hand and the great rise on the other in cost of labor and fuel, it cannot be said that the conference held in Birmingham yesterday by the consultative council of the National Federation of Ironmasters was convened a day too soon. For nearly two years past the trade has enjoyed an unwonted measure of prosperity, and both in the home and export departments consumptive demand in spite of gradually advancing prices has been large and increasing; but during the last two or three months there have been unmistakable signs that the "boom" is practically exhausted for the present, and the last advance, apparently, has been the proverbial feather that breaks the camel's back. For the month of July our exports amounted only to 267,143 tons, against 370,014 tons for July, 1899, and 281,194 tons in 1898. For the first time for many months, moreover, there is a reduction of values, which have been, for the same month, £2,558,116 (=$12,449,071.51), as compared with £2,631,313 ($12 805,284.21) in 1899. All the symptoms, we may add, point to further and greater reductions under both heads for the month which is now drawing to a close, although there is abundant evidence of large consumptive requirements in all parts of the world. The obvious explanation of the matter is that prices have advanced too rapidly, and consumers flatly refuse to pay them—at all events until they are convinced of their probable stability. That, necessarily, is a work of time; and, while the grass grows, we know the steed, however robust, is apt to starve.

What, then, is to be done? The ironmasters declare that they are powerless in the matter. Some advance they were certainly entitled to, as Sir Benjamin Hingley pointed out yesterday, after the many lean years they have lately experienced; but the greater part of the rise from which the trade is now suffering has been forced upon them, in the first place, by the higher wages to which the workpeople have become entitled under the sliding scale and, secondly and principally, by the enormous advance in coal, which is crippling our industries all round. Sir Benjamin Hingley is himself a coal owner, but he does not hesitate to condemn the short-sighted rapacity of his fellow coal owners in clapping shilling after shilling upon the price of fuel in reckless disregard of consequences. There is many a true word uttered in joke, and if a few large coal consuming firms were willing to act seriously upon Sir Benjamin's suggestion and "go on strike" for a few months, it would have more effect, we think, than any arguments or formal resolutions in bringing coal owners to their senses. The meeting yesterday, however, was evidently not a combative one—not in favor of heroic remedies—and after a sufficiently protracted discussion of the general question, they came to the conclusion to leave the coal owners to pursue their own devices, and contented themselves with a pious expression of opinion that the price of iron should be maintained. That is a resolution, of course, which binds nobody, and which is likely to have as much influence upon the market as an old nursery rhyme. Prices in this district, at all events, are not being maintained, and in spite of the advance in coal and wages many ironmasters will be unable to maintain them, because they must get orders, even at a slight loss, to keep their works going, or incur a much heavier loss by closing their works. American competition, moreover, is a serious factor to be reckoned with, though Sir Benjamin Hingley is evidently of opinion that it is overrated, and if the importation of American iron, or rather mild steel, continues to increase at the rate it has recently done, it must cause in time a considerable displacement of English iron and a corresponding diminution of our coal consumption, which should soon convince coal owners of the folly of their ways.—Marshal Halstead, Consul at Birmingham.

A New Way to Increase Our Exports.—In my replies to inquiries from manufacturers in our country as to how to gain foreign markets for their products, as also in my reports to the Department, I have impressed, says Simon W. Hanauer, Vice Consul-General, Frankfort, upon our exporters the necessity of personally studying the wants of foreign markets; of meeting the usual terms of credit, time and place of delivery, standard of weight and measure; of knowing the language of customers; of combination in foreign trade, etc.

There is another mode which promises splendid returns for those employing it, which will also stimulate our export trade. This consists in establishing American department stores in the large European cities.

In Germany and most other Continental countries, there are large retail warehouses and stores which sell different lines of dry goods and clothing for female wear. Department stores on the order of our own, containing almost everything for human needs, are hardly known here. Consequently one finds in a European city hundreds of retail stores, carrying small stocks and selling articles at high prices. I think department stores would find conditions more favorable here than at home, in amount of sales and return on the capital invested; but the importance of the plan consists in the immense impetus they would give to the sale of American specialties—household articles of all kinds, clothing, kitchen and iron ware, small machines, tools and instruments, toys, carriages and vehicles, office and dwelling furniture, fruits and meat, etc. I am confident that such a concern established in Frankfort could, within a few years, sell American specialties alone to an amount of $3,000,000 to $4,000,000 annually, and distribute further quantities by giving agencies to leading dealers of interior towns and cities. In shoes alone it could transact a large trade. Our manufacturers need them, but offer their products to the home-purchasing office, in order to do a foreign trade.

United States Sample Room in Zurich.—I take pleasure in informing the Department that a practical way of introducing American goods into Switzerland has at last been evolved, and will be carried into execution in the near future, says Consul A. Lieberknecht, of Zurich. The writing of letters, distribution of circulars, etc., is useless in foreign trade. An agent, understanding the business habits of the people and the kind of goods desired, must be on the ground in person, not only for a day or two, but all the year round. Zurich is the commercial center of Switzerland and a sample room here will be of great advantage to American manufacturers.

Mr. W. A. Steinmann, a native of Switzerland, who has spent six or seven years in the United States—a practical and successful business man—is willing to devote a few rooms as sample apartments for American goods, and to exhibit them to the best advantage. I prefer to give his own language as to his plans and intentions:

"In May next, I shall move my present business into buildings which are much larger—so large that they would be sufficient to make a beginning in the above-mentioned business. I have four traveling clerks and five agents that go to every corner of Switzerland. Therefore a beginning would be made with little additional expense, and if I should not succeed there will be little lost. However, taking the matter in hand as I am used to doing trade, I am sure that I can build up a business worth having. The name of the firm would be 'First American Import House for Switzerland, Zurich,' general manager, Wm. A. Steinmann. Naturally, it would have my personal guarantee and responsibility. I shall take the general agency for the whole of Switzerland of the most powerful and largest manufacturers (not merchants) in the United States; they must all be A 1 firms that can compete with anyone in the United States, and they must agree not to enter into business relations with any other firm in Switzerland. They are to send me all the samples required to give a clear idea of their articles, free of charge and delivered to my store. I shall not confine myself to any special line of goods, but will handle all salable articles, such as chemicals, wood, leather, shoes, tools of all descriptions, hardware and machinery, metals, minerals, food stuffs, inventions of all kinds, etc. I agree to open a large and fine exhibition of samples, to advertise them extensively, and to introduce the goods into our markets. My sales at the beginning would be on commission, and the manufacturers would have to ship their goods to the buyers with direct invoice, as the new firm will not take any responsibility for pay; but being a business man who knows the financial standing of almost everybody, and having 5,000 customers in my own business, loss is absolutely excluded. The firms that I represent as sole agent in Switzerland must accommodate themselves more or less to the customs prevailing in our country if they want to succeed, i. e., they will have to sell three or six months' time against draft. The great mistake American exporters make is that they always want to be paid cash. All European exporters to the United States give trustworthy firms credit, and that is what the latter will have to do, too, in order to establish a large foreign trade. It is the custom of this country."

Such a course as outlined above is the only proper way to introduce and sell goods in Switzerland. I trust that our manufacturers will meet the requirements.

German Trade in Scissors and Knives.—Consul-General Guenther writes from Frankfort, August 9, 1900:

Within a comparatively short space of time, the better class of scissors and shears has advanced in price about 10 per cent. and the commoner grades about 20 per cent. In knives of the better grades, there has been an appreciation of 5 to 7 per cent., and in the commoner grades of 10 to 25 per cent.

Except in pearl-handled knives, which have advanced largely on account of the increased cost of pearl, the appreciation in values is not due to the influence of raw material; it is practically altogether due to labor troubles. The fact that the men employed on the higher class of goods are being paid better than those working on the lower grades explains the difference in the increase in the price of the two grades of goods.

Taking into account the labor troubles and the fact that the manufacturers are busy, it is probable that German goods will be steady in price for some time to come.

Iron Bedsteads and Hardware in Syria.—Consul Schuman writes from Mainz, August 20, 1900:

A German export journal calls attention to the fact that iron bedsteads are being successfully introduced in North Syria. In 1899, about 3,750 iron bedsteads were imported at Beirut from Birmingham, England. The selling price was about £2 10s. ($12.16) for each bedstead.

At Haifa, North Palestine, industrial development is to be noted, which is largely due to the building of the railroad from Haifa to Damascus. There is a growing demand for carpenters' tools, locks and other builders' hardware. These articles are at present only to be had in inferior quality, and are disproportionately high in price. To meet with a ready sale, they must be simple and strong in construction.

Protecting the German Corset Industry.—Under date of July 30, 1900, Consul Warner, of Leipzig, reports that a number of Rhenish corset manufacturers wish to have the duty on corsets imported into Germany increased, owing to the keen competition which they are experiencing from foreign manufacturers. They have requested that the rate of duty should be fixed at 18 marks ($4.28) per dozen. A note of this kind was addressed to the Chamber of Commerce of Stuttgart, a place where there are many corset factories, and, after looking into the subject, the Stuttgart Chamber of Commerce decided not to approve of the request, because such a high rate of duty would mean a prohibition of foreign corsets and might lead to foreigners establishing factories in Germany.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 835. September 17.—*United States Sample Room in Zurich—*Depression in European Textile Industries—*Critical Situation in British Iron Trade—Port Works at Montevideo—New Steamship Line to Mexico.

No. 836. September 18.—Knitting Industry in Latin America.

No. 837. September 19.—The Trans-Siberian Railroad—A New Way to Increase our Exports—Haitian Export Dues on Fruit—Cable Service at Pernambuco—New Bank in Antofagasta.

No. 838. September 20.—Almonds and Filberts in Spain—*Electric Traction for Canals—Orris-Root Trust—Automobile Taxes in Spain—Complaints of Russian Wheat.

No. 839. September 21.—Leipzig City Pawn Shop and Savings Institutions—*Protecting the German Corset Industry—*American Factory Timekeepers Wanted in Germany.

No. 840. September 22.—British Butter, Cheese, and Egg Market—Milk Inspection in Leipzig—Currant Crop of Greece—*Opening for American Folding Beds in South Germany—New Use of Liquid Air.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

SWIMMING EXERCISES OF THE PRUSSIAN ARMY.

STREAMS are most naturally and easily crossed by means of bridges. But it often happens in time of war that bridges have been destroyed, and that, for lack of time, pontoon military bridges cannot be constructed. For such cases Prussian tacticians have provided certain drills which must be mastered by all the troops.

The artillery is to transport its guns in time of war by means of rafts made of casks lashed together, upon which a platform is to be secured. These rafts are to be towed by boats manned by the gun crews; the horses are to be led by their bridle-reins, as our second illustration shows.

Like the artillery, the cavalry is also drilled in crossing rivers. The horses, carrying their riders whenever possible, are made to swim to the opposite shore; but, when hampered by much baggage, the men cross the river in boats, the horses being guided by their bridle-reins.

For the patrol service no river should be impassable. When means of transportation are not at hand, the horses must needs carry their riders through the water. For such emergency cases, there are in every squadron a number of troopers hampered by no baggage whatever, and so lightly clad that they can swim through the water while clinging to the manes or tails of their horses. In time of war the saddles of the horses are to be left behind; and the troopers are to remove their boots. If, during the course of a battle, the cavalrymen are forced to take to the river by the enemy, they are to plunge in without any previous preparation, merely clinging to the manes or tails of their horses. If there be time enough, the baggage is to be carried across the river by boats in the manner previously described.

In time of peace the cavalrymen are drilled in swimming by a specially appointed officer who is personally responsible for the safety of the men under his care. Our illustration, taken from Illustrirte Zeitung, shows a division of the cuirassiers of the guards drilling in the upper Spree, near Niederschönweide.

THE CUIRASSIERS OF THE GUARDS DRILLING IN THE UPPER SPREE.

THE PROGRESS OF SCIENCE AND INVENTION.

IN the course of an address on "The Nineteenth Century," delivered to the University Extension students at Cambridge, Mr. Arthur J. Balfour, referring to the growth of invention and the correlation of all physical forces, remarked, says The Mechanical Engineer:

But in their total effects the advances made by the nineteenth century are not to be matched. Not only is the surprising increase of knowledge new, but the use to which it has been put is new also. The growth of industrial invention is not a fact we are permitted to forget. We do, however, sometimes forget that much of it is due to a close connection between theoretic knowledge and its utilitarian application, which in its degree is altogether unexampled in the history of mankind. I suppose that at this moment, if we were allowed a vision of the embryonic forces which are predestined most potently to affect the future of mankind, we should have to look for them not in the legislature, not in the press nor on the platform, not in the schemes of practical statesmen nor the dreams of political theorists, but in the laboratories of scientific students, whose names are but little in the mouths of men, who cannot themselves forecast the results of their own labors, and whose theories could scarce be understood by those whom they will chiefly benefit. I do not propose to attempt any sketch of our gains from this most fruitful union between science and invention. I may, however, permit myself one parenthetic remark on an aspect of it which is likely more and more to thrust itself unpleasantly upon our attention.

Marvelous as is the variety and ingenuity of modern industrial methods, they almost all depend in the last resort upon our supply of useful power. This is principally provided for us by methods which, as far as I can see, have altered not at all in principle and strangely little in detail since the days of Watt. Coal, as we all know, is the chief reservoir of energy from which the world at present draws, and from which we in this country must always draw. But our main contrivance for utilizing it is the steam engine, and by its essential nature the steam engine is extravagantly wasteful; so that when we are told, as if it were something to be proud of, that this is the age of steam, we may admit the fact, but can hardly share the satisfaction.

Our coalfields, as we know too well, are limited. We certainly cannot increase them. The boldest legislator would hesitate to limit their employment for purposes of domestic industry. So the only possible alternative is to economize our method of consuming them; and for this there would, indeed, seem to be a sufficiency of room. Let a second Watt arise. Let him bring into general use some mode of extracting energy from fuel which shall only waste 80 per cent. of it, and, lo! your coalfields as sources of power are doubled at once. The hope seems a modest one, but it is not yet fulfilled, and therefore it is that we must restrict the satisfaction with which, at the end of the century, we contemplate the unbroken course of its industrial triumphs. We have, in truth, been little better than brilliant spendthrifts. Every new invention seems to throw a new strain upon the vast, but not illimitable, resources of nature. Lord Kelvin is disquieted about our supply of oxygen, Sir William Crookes about our supply of nitrates.

The problem of our coal supply is always with us. Sooner or later the stored-up resources of the world will be exhausted. Humanity, having used or squandered its capital, will thenceforward have to depend upon such current income as can be derived from the diurnal heat of the sun and the rotation of the earth, till, in the sequence of the ages, these also begin to fail. With such remote speculations we are not now concerned. It is enough for us to take note how rapidly the prodigious progress of recent discovery has increased the drain upon the natural wealth of all manufacturing countries, and especially of Great Britain, and at the same time frankly to recognize that it is only by new inventions that the collateral evils of old inventions can be mitigated, that to go back is impossible, and that our only hope lies in a further advance. After all, however, it is not necessarily the material and obvious results of scientific discoveries which are of the deepest interest. They have effected changes more subtle and perhaps less obvious which are at least worthy of our consideration, and are at least as unique in the history of the civilized world.

No century has seen so great a change in our intellectual apprehension of the world in which we live. Our whole point of view has changed. The mental framework in which we arrange the facts in the world of men and things is quite a new framework. The spectacle of the universe presents itself now in a wholly changed perspective, and the scientists who have borne their share in thus recreating for us the evolution of the past are in process of giving us quite new ideas as to the inner nature of that material whole of which the worlds traversing space are but an insignificant part.

Differences of quality once thought ultimate are constantly being resolved into differences of motion or configuration. What was once regarded as things are now known to be movements. Phenomena apparently so wide apart as light, radiant heat, and electricity are, as it is unnecessary to remind you, now recognized as substantially identical. From the arrangement of atoms in the molecule not less than their intrinsic nature flow the characteristic attributes of the compound. The atom itself has been pulverized, and speculation is forced to admit as a possibility that even the chemical elements themselves may be no more than varieties of a single substance.

Plausible attempts have been made to reduce the physical universe, with its infinite variety, its glory of color and of form, its significance and its sublimity, to one homogeneous medium in which there are no distinctions to be discovered but distinctions of movement or of stress; and although no such hypothesis can, I suppose, be yet accepted, the gropings of physicists after this or some other not less audacious unification must finally, I think, be crowned with success. The change of view which I have endeavored to indicate is purely scientific; but its consequences cannot be confined to science. How will they manifest themselves in other regions of human activity—in literature, in art, in religion? The subject is one rather for the lecturer on the twentieth century than for the lecturer on the nineteenth. I, at least, cannot endeavor to grapple with it.

But, before concluding, I will ask one question about it, and hazard one prophecy. My question relates to art. We may, I suppose, say that artistic feeling constantly expresses itself in the vivid presentation of sensuous fact and its remote emotional suggestion. Will it be dulled by a theory of the world which carries with it no emotional suggestion, which is perpetually merging the sensuous fact in its physical explanation, whose main duty, indeed, it is to tear down the cosmic scene-painting and expose the scaffolding and wheelwork by which the world of sense-perception is produced? I do not know; I do not hazard a conjecture. But the subject is worth consideration.

We have frequently seen in the history of thought that any development of the mechanical conception of the physical world gives an impulse to materialistic speculation. Now, if the goal to which, consciously or unconsciously, the modern physicist is pressing be ever reached, the mechanical view of things will receive an extension and a completeness never before dreamed of. There would then, in strictness, be only one natural science, viz., physics; and only one kind of explanation, viz., the dynamic.

Prof. Sollas believes there is a coal field under the London basin at Enfield lock. He considers that it is the center of a large carboniferous area, and he advises borings to ascertain the truth of his theory.

REMARKABLE EFFECTS OF THE INDIAN EARTHQUAKE.

DR. CHARLES DAVISON, in an interesting article in Knowledge for August, on the effects of the earthquake of 1897, writes as follows:

"Prominent among the earthquake effects are the fissures formed in alluvial plains. Mr. Oldham estimates that, where the necessary conditions prevail, fissures were fairly frequent over a region which measures about 400 miles from east to west, and about 350 miles from north to south, and present in smaller numbers over one nearly 600 miles in length from east to west. They were naturally more numerous near river channels and reservoirs, on account of the absence of lateral support, and as a rule were parallel to the edge of the bank, a few hundred yards in length, and varying in width from a few inches to four or five feet. Fissures in such positions are usually formed during every severe earthquake. But an interesting point established by the Indian earthquake is that they were also found in places far removed from any water channel or excavation; sometimes running parallel to and along either side of a road or embankment; at other times skirting the foot of hills; but in every case clearly due to the compression of the alluvium during the passage of the earth-waves. . . . Telegraph posts were displaced sometimes as much as ten or fifteen feet. In one part of the Asam-Bengal Railway the whole embankment, including borrow-pits and trees on either side, was shifted laterally through a distance of 6 feet 9 inches. Rice fields in northern Bengal, lower Assam, etc., which had been carefully leveled so that they might be uniformly flooded, were thrown into gentle undulations, the crests of which were occasionally two or three feet above the hollows. The piers of bridges were moved alongside, as well as toward the stream. Rails were bent over an unusually large area, the compression caused by the crumpling being always compensated by expansion elsewhere."

CONTEMPORARY ELECTRICAL SCIENCE.*

THERMODYNAMICS OF CELLS.—It is now pretty generally admitted that every current of heat produces an electric current, and vice versa. C. Liebenow attempts to account for this by assuming that the heat consists in the vibrations of the negative particles, now usually called electrons. Anything which moves these negative electrons will move the heat attached to them by convection, and so every electric current will go hand in hand with a heat current. The amount of heat can be calculated from the equation

$$q = -0{\cdot}24\,Ti\frac{dE}{dT}$$

which gives the amount of heat conveyed by a current i through any cross-section of the metal in one second. For copper, the amount of heat thus supplied to each gramme-atom precipitated from solution would be 870 calories at 0°. But since the total heat of the gramme-atom is about twice that amount, it may be said that half the total heat of the metal is conveyed by the negative electron and the other half by the positive electron. The author further shows that all metals in the solid state are monovalent, and that the atomic heat of negative and positive electrons is $870/273 = 3{\cdot}2$, or about the same as the atomic heat of monatomic gases at constant volume.—C. Liebenow, Ann. der Physik, No. 7, 1900).

SPECTRUM OF RADIUM.—Among the radio-active substances discovered since Becquerel's description of the peculiar properties of uranium rays, radium has proved to be the most interesting. It is capable of sending out both cathode rays and Roentgen rays without being electrically excited. It emits these rays in great intensity, comparatively speaking, and with an apparently unlimited supply of energy. We know now that even if the energy of the body is being spent and diminished in the process, such diminution would not become apparent for a number of years, and this consideration saves the law of the conservation of energy in our estimation. But the mode of excitation of radium is as yet unknown, nor has the metal itself been as yet isolated, although it has been obtained as a chloride. This might produce suspicions as to its elementary character were it not for the almost conclusive evidence of the spectroscope. Some time ago (see The Electrician, vol. xliv., page 140) E. Demarçay identified certain spectrum lines with radium, and he now produces further evidence for the identity then established. In addition to the strong and bright lines of wave lengths 3,815, 4,341, and 4,683, he noticed a band at 4,627 and another at 4,455. This brings the spectrum into close analogy with the spectra of the metals of the alkaline earths. It would be interesting to determine how the spectrum rules discovered by Kayser and Runge are obeyed by these new lines.—E. Demarçay, Comptes Rendus, July 23, 1900.

THERMODYNAMICS OF A VOLTAIC CELL.—The theory, commonly known as Thomson's, that the electrical energy of a reversible voltaic cell is the equivalent of the chemical energy transformed, has been abandoned as an exact expression of the facts since the appearance of Helmholtz's paper on "The Thermodynamics of Chemical Processes," in 1882, and Jahn's experimental corroboration. Some of the chemical energy may appear as heat direct, as in the Clark cell, which has a negative temperature coefficient. Helmholtz's calomel cell, which has a positive temperature coefficient, absorbs heat and cools down in generating a current. In Daniell's cell, on the other hand, there is a strict equivalence between the electrical energy evolved and the difference between the heat of combination of the zinc sulphate formed and the copper sulphate decomposed. H. S. Carhart has studied this process in detail, and has for this purpose treated the positive and negative sides of a cell separately. He shows that the most important determining quantity—the temperature coefficient of the E.M.F. of the cell—is made up of the sum

$$\left(\frac{dE}{dT}\right)_p + \left(\frac{dE}{dT}\right)_n$$

at the positive and negative poles respectively. These are the Peltier effects at the junction between each electrode and its liquid. In practice, the quantitative values obtained are complicated by changes of concentration, which, however, the author has succeeded in eliminating.—H. S. Carhart, Phys. Review, July, 1900.

MAGNETIC INTENSITY VARIOMETERS.—The magnetism of a bar and the directive force of a bifilar suspension are not free from changes in the course of time and are greatly affected by temperature. M. Eschenhagen has therefore adopted quartz fibers in order to obtain a simple torsional suspension. The systems of magnets and suspensions usually employed with magnetometers weigh at least 20 grammes to 30 grammes, and are therefore not suited for quartz fibers, as the latter would have to be too thick for the proper sensitiveness. The author has therefore provided a light system of magnets weighing about 1·5 grammes, and has found them to possess several distinct advantages, such as easy accessibility, adjustable damping, and a fixed mirror for photographic registration, which can be displaced with ease and certainty. For intensity variometers, a quartz fiber, not too thin, about $\frac{1}{10}$ mm. to $\frac{1}{15}$ mm. thick, is selected, and the upper end is twisted until the magnet lies perpendicularly to the magnetic meridian. The author employs a simple expedient for increasing the sensitiveness of an instrument. He uses a fixed directive magnet parallel to the needle and below it. If the poles of the directive magnet are placed opposite the like poles of the needle, the instrument becomes more sensitive; if in the contrary position, it becomes less sensitive.—M. Eschenhagen, Terr. Magnetism, June, 1900.

CAUSE OF TERRESTRIAL MAGNETISM.—An interesting attempt to reduce the phenomena of terrestrial magnetism to electric convection currents has been made by W. Sutherland. He supposes that the primary magnetic field of the earth is produced by a surface charge of negative electricity, which revolves with the earth, and whose motion through the ether produces the magnetic field. Astronomically, however, the earth does not act as a negatively-charged body, as its surface charge is compensated by an equal positive charge at the center. The author shows that the surface density required would be 51,000 electrostatic units. The magnetic field outside the earth would be the only external evidence of the existence of the electrostatic field within. Secular variation is accounted for by a dissymmetry of the conductivity of the earth's crust, which induces a transverse field and produces a potential similar to that of Barons' hypothetical transverse magnet. As regards the daily variation, the author points out that the process of dissociation induced by the sun in the upper strata of the atmosphere would produce a downward current of positive ions, and this would be the earth-air current to which the diurnal and other short-period variations have already been attributed. The currents are closed by flowing along the surface of the earth from equator to pole, by the glow discharge of the aurora in polar regions, and in the upper atmosphere by flowing from the pole to the equator.—W. Sutherland, Terr. Magnetism, June, 1900.

DIELECTRIC STRAIN.—The expansion of a dielectric in an electrostatic field has been adduced as an experimental proof of the theories of Faraday and Maxwell, but the results described are anything but concordant. Roentgen ascribes the observed changes of volume to the electric compression of the electrodes and the heating effect of the free charges on the surface of the glass or liquid. L. T. More has endeavored to meet

THE TRANSPORTATION OF GUNS ACROSS A RIVER BY THE GERMAN ARTILLERY.

* Compiled by E. E. Fournier d'Albe, in The Electrician.

this criticism by a special arrangement of three concentric tubes, the inner one being brass, inclosed in a glass tube surrounded by another brass tube. The results of his experiments, however, lead him to the conclusion that the stress occurring in the ether when a dielectric is electrostatically charged causes a mechanical deformation of the substance. At least, if there is such an action, it must be extremely minute—perhaps a slight re-arrangement of the molecular structure—as an effect so large as one expressed by the formula $KH^2/8\pi$ would be very appreciable. Though it might have been expected that such ethereal stresses would change the length of a dielectric both along and at right angles to the lines of induction, yet as one of these is a tension and the other a compression of equal amount, it is difficult to see how any change of volume other than a differential effect would result; whereas Quincke finds that the change of volume is nearly three times as large as the linear expansion. A strain as indicated is not met with in any allied field of investigation.—L. T. More, Phil. Mag., August, 1900.

FACTS ABOUT "MILITARISM."

WHEN Gen. Manderson made the graduation day speech to the class of 1900 at West Point on June 13, he devoted a few sentences to "militarism." In the course of his remarks Gen. Manderson referred to certain tables which he had prepared. He did not read the tables, but contented himself with presenting very forcibly some of the facts which the figures in them demonstrated.

The tables in question are herewith given. Gen. Manderson, in speaking of them after his address, said that he had them prepared with very great care. The figures in them, so far as they refer to foreign countries, were obtained after a great deal of correspondence and at considerable expenditure of time, from the highest authorities in the foreign lands in question, and were as far as possible brought down to the very latest date possible prior to the preparation of his speech. The home statistics are compiled from official government tables. It was Gen. Manderson's idea to be accurate beyond possibility of dispute, and in cases where estimates were necessary he leaned so far toward conservatism as to be far within the boundaries of actual fact rather than a hair's breadth beyond them.

His first table, which is devoted to the proportion of soldiers to population in the different countries of the world, is as follows:

	Population.	Army in Peace in 1900.	Number Soldiers to Each 1,000 Population.
France	38,517,905	540,405	14·00
Germany	52,270,901	587,933	14·30
Austria-Hungary	41,827,500	352,429	8·40
Russia	128,962,173	896,000	6·90
Turkey	33,569,787	213,910	6·30
Italy	29,880,785	324,686	10·80
Great Britain	37,888,439	258,348	6·80
United States	75,000,000	65,' 00	0·86
	Population.	Army in Present War.	
Great Britain	37,888,439	503,484	13·20
United States	75,000,000	100,000	1·33

Note.—The population of the United States in 1900 was 62,622,250. For the purpose of the tables it is estimated at 75,000,000. The permissible regular army until July 1, 1901, is 65,000. The permissible volunteer army is 35,000; actually now 31,856; to be reduced next year, under existing law, to 27,451 regulars, and the entire volunteer force to be discharged.

Gen. Manderson points out from these figures that in France and Germany, which are always cited in talks about militarism, there are from 14 to 14·3 soldiers to every 1,000 of population. In Italy there are 10·8 soldiers to every 1,000 inhabitants. In the United States in 1899, when the army consisted of 65,000 men, there was only a fraction—0·86—of one soldier to terrify, overawe, and grind under the iron heel of "militarism" every 1,000 American citizens. When the insurrection broke out in the Philippines, permission was given to increase the army of 65,000 regulars by 35,000 volunteers, making the total American force 100,000 men, spread over an area that, from extreme limit to extreme limit, half encircled the world. Taking the population of the country still at 75,000,000, that makes one soldier and not quite a third of another to overawe each 1,000 of our American population. But, unless Congress amends the present law, the regular army will, on July 1 next, be reduced to 27,451 men and the volunteers dismissed altogether. Then we will have about a quarter of one soldier to overawe a thousand Americans, or one full soldier to hold 4,000 Americans squirming in his mailed hand. That is the kind of a "militarism" goblin, Gen. Manderson says, that will "git ye if you don't watch out" and vote for 50-cent dollars and Col. Bryan. Even Great Britain, which it is admitted is not affected with "militarism," has 6·8 soldiers to every 1,000 of population.

Gen. Manderson's second table shows the proportion of soldiers in the different countries in the world to the area in square miles of those countries. It is as follows:

	Area in Square Miles.	Army in Peace.	Soldiers to Each Square Mile.	Square Miles to Each Soldier.
France	204,177	540,405	2·6	0·37
Germany	211,108	587,933	2·7	0·35
Austria-Hungary	201,591	352,429	1·2	0·57
Russia	8,660,395	896,000	0·13	9·60
Turkey	1,659,543	213,910	0·12	7·70
Italy	110,465	324,686	2·9	0·34
Great Britain	120,973	258,348	2·1	0·46
United States	3,602,884	65,000	0·018	55·40
	Area in Square Miles.	Army in Present War.		
Great Britain	120,973	503,484	4·1	0·23
United States	3,602,884	100,000	0·029	36·00

From this table it appears that with an army of 65,000 men, as it was in 1899, a soldier had to spread himself over more than fifty-five square miles to do his share toward devastating the country with "militarism," while even with the army at 100,000 men each soldier has thirty-six square miles of land to cover. If the army is reduced to 27,451 men each soldier will have the task of making the iron chains of "militarism" clank over an area of something like 100 square miles and will have to keep about 4,000 American citizens under the galling "militarism" yoke.

Gen. Manderson's third table is devoted to the war budgets of the different countries, with reference to their populations and the amount per capita it costs the people. The table is as follows:

	Population.	War Budget.	Year of Budget.	Amount per Capita.
France	38,517,905	$123,517,681	1898	$3.20
Germany	52,270,901	141,175,350	1898	2.70
Austria-Hungary	41,827,500	86,098,034	1897	2·05
Russia	128,962,173	148,640,191	1898	1.15
Turkey	33,569,787	19,921,755	1897	0.59
Italy	29,880,785	45,650,669	1898	1.52
Great Britain	37,888,439	88,152,750	1897	2.32
United States	75,000,000	51,003,927	1896	0.68

It will be observed from this table that while each French citizen pays $3.20, each German $2.70, each Austrian $2.05, and each subject in Great Britain $2.32, Americans get "militarism" at a net cost of 68 cents per head.

[Continued from SUPPLEMENT, No. 1291, page 20690.]

INAUGURAL ADDRESS.

By Prof. Sir WILLIAM TURNER, President of the British Association for the Advancement of Science, Bradford Meeting.

CELL PLASM.

IN the cells of plants, in addition to the cell wall, the cell body and the cell juice require to be examined. The material of the cell body, or the cell contents, was named by Von Mohl (1846) protoplasm, and consisted of a colorless tenacious substance which partly lined the cell wall (primordial utricle), and partly traversed the interior of the cell as delicate threads inclosing spaces (vacuoles) in which the cell juice was contained. In the protoplasm the nucleus was embedded. Nägeli, about the same time, had also recognized the difference between the protoplasm and the other contents of vegetable cells, and had noticed its nitrogenous composition.

Though the analogy with a closed bladder or vesicle could no longer be sustained in the animal tissues, the name "cell" continued to be retained for descriptive purposes, and the body of the cell was spoken of as a more or less soft substance inclosing a nucleus (Leydig). In 1861 Max Schultze adopted for the substance forming the body of the animal cell the term "protoplasm." He defined a cell to be a particle of protoplasm in the substance of which a nucleus was situated. He regarded the protoplasm, as indeed had previously been pointed out by the botanist Unger, as essentially the same as the contractile sarcode which constitutes the body and pseudopodia of the Amœba and other Rhizopoda. As the term "protoplasm," as well as that of "bioplasm," employed by Lionel Beale in a somewhat similar though not precisely identical sense, involves certain theoretical views of the origin and function of the body of the cell, it would be better to apply to it the more purely descriptive term "cytoplasm" or "cell plasm."

Schultze defined protoplasm as a homogeneous, glassy, tenacious material, of a jelly-like or somewhat firmer consistency, in which numerous minute granules were embedded. He regarded it as the part of the cell especially endowed with vital energy, while the exact function of the nucleus could not be defined. Based upon this conception of the jelly-like character of protoplasm, the idea for a time prevailed that a structureless, dimly granular, jelly or slime, destitute of organization, possessed great physiological activity, and was the medium through which the phenomena of life were displayed.

More accurate conceptions of the nature of the cell plasm soon began to be entertained. Brücke recognized that the body of the cell was not simple, but had a complex organization. Flemming observed that the cell plasm contained extremely delicate threads, which frequently formed a network, the interspaces of which were occupied by a more homogeneous substance. Where the threads crossed each other, granular particles (mikrosomen) were situated. Bütschli considered that he could recognize in the cell plasm a honeycomb-like appearance, as if it consisted of excessively minute chambers in which a homogeneous, more or less fluid, material was contained. The polar and spindle-like radiations visible during the process of karyokinesis, which have already been refered to, and the presence of the centrosome, possibly even during the resting stage of the cell, furnished additional illustrations of differentiation within the cell plasm. In many cells there appears also to be a difference in the character of the cell plasm which immediately surrounds the nucleus and that which lies at and near the periphery of the cell. The peripheral part (ektoplasma) is more compact and gives a definite outline to the cell, although not necessarily differentiating into a cell membrane. The inner part (endoplasma) is softer, and is distinguished by a more distinct granular appearance, and by containing the products specially formed in each particular kind of cell during the nutritive process.

By the researches of numerous investigators on the internal organization of cells in plants and animals, a large body of evidence has now been accumulated, which shows that both the nucleus and the cell plasm consist of something more than a homogeneous, more or less viscid, slimy material. Recognizable objects in the form of granules, threads or fibers can be distinguished in each. The cell plasm and the nucleus respectively are therefore not of the same constitution throughout, but possess polymorphic characters, the study of which in health and the changes produced by disease will for many years to come form important matters for investigation.

FUNCTION OF CELLS.

It has already been stated that, when new cells arise within pre-existing cells, division of the nucleus is associated with cleavage of the cell plasm, so that it participates in the process of new cell-formation. Undoubtedly, however, its rôle is not limited to this function. It also plays an important part in secretion, nutrition, and the special functions discharged by the cells in the tissues and organs of which they form morphological elements.

Between 1838 and 1842 observations were made which showed that cells were constituent parts of secreting glands and mucous membranes (Schwann, Henle). In 1842 John Goodsir communicated to the Royal Society of Edinburgh a memoir on secreting structures, in which he established the principle that cells are the ultimate secreting agents; he recognized in the cells of the liver, kidney, and other organs the characteristic secretion of each gland. The secretion was, he said, situated between the nucleus and the cell wall. At first he thought that, as the nucleus was the reproductive organ of the cell, the secretion was formed in the interior of the cell by the agency of the cell wall; but three years later he regarded it as a product of the nucleus. The study of the process of spermatogenesis by his brother, Harry Goodsir, in which the head of the spermatozoon was found to correspond with the nucleus of the cell in which the spermatozoon arose, gave support to the view that the nucleus played an important part in the genesis of the characteristic product of the gland cell.

The physiological activity of the cell plasm and its complex chemical constitution soon after began to be recognized. Some years before Max Schultze had published his memoirs on the characters of protoplasm, Brücke had shown that the well-known changes in tint in the skin of the chameleon were due to pigment granules situated in the cells in the skin which were sometimes diffused throughout the cells, at others concentrated in the center. Similar observations on the skin of the frog were made in 1854 by Von Wittich and Harless. The movements were regarded as due to contraction of the cell wall on its contents. In a most interesting paper on the pigmentary system in the frog, published in 1858, Lord Lister demonstrated that the pigment granules moved in the cell plasma, by forces resident within the cell itself, acting under the influence of an external stimulant, and not by contractility of the wall. Under some conditions the pigment was attracted to the center of cell, when the skin became pale; under other conditions the pigment was diffused throughout the body and the branches of the cell, and gave to the skin a dark color. It was also experimentally shown that a potent influence over these movements was exercised by the nervous system.

The study of the cells of glands engaged in secretion, even when the secretion is colorless, and the comparison of their appearance when secretion is going on with that seen when the cells are at rest, have shown that the cell plasm is much more granular and opaque, and contains larger particles during activity than when the cell is passive: the body of the cell swells out from an increase in the contents of its plasm, and chemical changes accompany the act of secretion. Ample evidence therefore is at hand to support the position taken by John Goodsir, nearly sixty years ago, that secretions are formed within cells, and lie in that part of the cell which we now say consists of the cell plasm; that each secreting cell is endowed with its own peculiar property, according to the organ in which it is situated, so that bile is formed by the cells in the liver, milk by those in the mamma, and so on.

Intimately associated with the process of secretion is that of nutrition. As the cell plasm lies at the periphery of a cell, and as it is, alike both in secretion and nutrition, brought into closest relation with the surrounding medium, from which the pabulum is derived, it is necessarily associated with the nutritive activity. Its position enables it to absorb nutritive material directly from without, and in the process of growth it increases in amount by interstitial changes and additions throughout its substance, and not by mere accretions on its surface.

Hitherto I have spoken of a cell as a unit, independent of its neighbors as regards its nutrition and the other functions which it has to discharge. The question has, however, been discussed, whether in a tissue composed of cells closely packed together cell plasm may not give origin to processes or threads which are in contact or continuous with corresponding processes of adjoining cells, and that cells may therefore, to some extent, lose their individuality in the colony of which they are members. Appearances were recognized between 1863 and 1870 by Schrön and others in the deeper cells of the epidermis and of some mucous membranes which gave sanction to this view, and it seems possible, through contact or continuity of threads connecting a cell with its neighbors, that cells may exercise a direct influence on each other.

Nägeli, the botanist, as the foundation of a mechanico-physiological theory of descent, considered that in plants a network of cell plasm, named by him idio-plasm, extended throughout the whole of the plant, forming its specific molecular constitution, and that growth and activity were regulated by its conditions of tension and movements (1884).

The study of the structure of plants with special reference to the presence of an intercellular network has for some years been pursued by Walter Gardiner (1883–97), who has demonstrated threads of cell plasm protruding through the walls of vegetable cells and continuous with similar threads from adjoining cells. Structurally, therefore, a plant may be conceived to be built up of a nucleated cytoplasmic network, each nucleus with the branching cell plasm surrounding it being a center of activity. On this view a cell would retain to some extent its individuality, though, as Gardiner contends, the connecting threads would be the medium for the conduction of impulses and of food from a cell to those which lie around it. For the plant cell therefore, as has long been accepted in the animal cell, the wall is reduced to a secondary position, and the active constituent is the nucleated cell plasm. It is not unlikely that the absence of a controlling nervous system in plants requires the plasm of adjoining cells to be brought into more immediate contact and continuity than is the case with the generality of animal cells, so as to provide a mechanism for harmonizing the nutritive and other functional processes in the different areas in the body of the plant. In this particular, it is of interest to note that the epithelial tissues

in animals, where somewhat similar connecting arrangements occur, are only indirectly associated with the nervous and vascular systems, so that, as in plants, the cells may require, for nutritive and other purposes, to act and react directly on each other.

NERVE CELLS.

Of recent years great attention has been paid to the intimate structure of nerve cells, and to the appearance which they present when in the exercise of their functional activity. A nerve cell is not a secreting cell; that is, it does not derive from the blood or surrounding fluid a pabulum which it elaborates into a visible, palpable secretion characteristic of the organ of which the cell is a constituent element, to be in due course discharged into a duct which conveys the secretion out of the gland. Nerve cells, through the metabolic changes which take place in them in connection with their nutrition, are associated with the production of the form of energy specially exhibited by animals which possess a nervous system, termed nerve energy. It has long been known that every nerve cell has a body in which a relatively large nucleus is situated. A most important discovery was the recoguition that the body of every nerve cell had one or more processes growing out from it. More recently it has been proved, chiefly through the researches of Schultze, His, Golgi and Ramon y Cajal, that at least one of the processes, the axon of the nerve cell, is continued into the axial cylinder of a nerve fiber, and that in the multipolar nerve cell the other processes, or dendrites, branch and ramify for some distance away from the body. A nerve fiber is therefore an essential part of the cell with which it is continuous, and the cell, its processes, the nerve fiber and the collaterals which arise from the nerve fiber collectively form a neuron or structural nerve unit (Waldeyer). The nucleated body of the nerve cell is the physiological center of the unit.

The cell plasm occupies both the body of the nerve cell and its processes. The intimate structure of the plasm has by improved methods of observation introduced during the last eight years by Nissl, and conducted on similar lines by other investigators, become more definitely understood. It has been ascertained that it possesses two distinct characters which imply different structures. One of these stains deeply on the addition of certain dyes, and is named chromophile or chromatic substance; the other, which does not possess a similar property, is the achromatic network. The chromophile is found in the cell body and the dendritic processes, but not in the axon. It occurs in the form of granular particles, which may be scattered throughout the plasm, or aggregated into little heaps which are elongated or fusiform in shape and appear as distinct colored particles or masses. The achromatic network is found in the cell body and the dendrites, and is continued also into the axon, where it forms the axial cylinder of the nerve fiber. It consists apparently of delicate threads or fibrillæ, in the meshes of which a homogeneous material, such as is found in the cell plasm generally, is contained. In the nerve cell, as in other cells, the plasm is without doubt concerned in the process of cell nutrition. The achromatic fibrillæ exercise an important influence on the axon or nerve fiber with which they are continuous, and probably they conduct the nerve impulses which manifest themselves in the form of nerve energy. The dendritic processes of a multipolar nerve cell ramify in close relation with similar processes branching from other cells in the same group. The collaterals and the free end of the axon fiber process branch and ramify in association with the body of a nerve cell or of its dendrites. We cannot say that these parts are directly continuous with each other to form an intercellular network, but they are apparently in opposition, and through contact exercise influence one on the other in the transmission of nerve impulses.

There is evidence to show that in the nerve cell the nucleus, as well as the cell plasm, is an effective agent in nutrition. When the cell is functionally active, both the cell body and the nucleus increase in size (Vas, G. Lugaro); on the other hand, when nerve cells are fatigued through excessive use, the nucleus decreases in size and shrivels; the cell plasm also shrinks, and its colored or chromophile constituent becomes diminished in quantity, as if it had been consumed during the prolonged use of the cell (Hodge, Mann, Lugaro). It is interesting also to note that in hibernating animals in the winter season, when their functional activity is reduced to a minimum, the chromophile in the plasm of the nerve cell is much smaller in amount than when the animal is leading an active life in the spring and summer (G. Levi).

When a nerve cell has attained its normal size, it does not seem to be capable of reproducing new cells in its substance by a process of karyokinesis, such as takes place when young cells arise in the egg and in the tissues generally. It would appear that nerve cells are so highly specialized in their association with the evolution of nerve energy, that they have ceased to have the power of reproducing their kind, and the metabolic changes both in cell plasm and nucleus are needed to enable them to discharge their very peculiar function. Hence it follows that when a portion of the brain or other nerve center is destroyed, the injury is not repaired by the production of fresh specimens or their characteristic cells, as would be the case in injuries to bones and tendons.

In our endeavors to differentiate the function of the nucleus from that of the cell plasm, we should not regard the former as concerned only in the production of young cells, and the latter as the exclusive agent in growth, nutrition, and where gland cells are concerned, in the formation of their characteristic products. As regards cell reproduction also, though the process of division begins in the nucleus in its chromosome constituents, the achromatic figure in the cell plasm undoubtedly plays a part, and the cell plasm itself ultimately undergoes cleavage.

A few years ago the tendency among biologists was to ignore or attach but little importance to the physiological use of the nucleus in the nucleated cell, and to regard the protoplasm as the essential and active constituent of living matter; so much so, indeed, was this the case that independent organisms regarded as distinct species were described as consisting of protoplasm destitute of a nucleus; also that scraps of protoplasm separated from larger nucleated masses could, when isolated, exhibit vital phenomena. There is reason to believe that a fragment of protoplasm, when isolated from the nucleus of a cell, though retaining its contractility and capable of nourishing itself for a short time, cannot increase in amount, act as a secreting structure, or reproduce its kind; it soon loses its activity, withers, and dies. In order that these qualities of living matter should be retained, a nucleus is by most observers regarded as necessary (Nussbaum, Gruber, Haberlandt, Korscheit), and for the complete manifestation of vital activity both nucleus and cell plasm are required.

BACTERIA.

The observations of Cohn, made about thirty years ago, and those of De Bary shortly afterward, brought into notice a group of organisms to which the name "bacterium" or "microbe" is given. They were seen to vary in shape; some were rounded specks called cocci, others were straight rods called bacilli, others were curved or spiral rods, vibrios or spirillæ. All were characterized by their extreme minuteness, and required for their examination the highest powers of the best microscopes. Many bacteria measure in their least diameter not more than $\frac{1}{25000}$ of an inch, $\frac{1}{10}$ the diameter of a human white blood corpuscle. Through the researches of Pasteur, Lord Lister, Koch, and other observers bacteria have been shown to play an important part in nature. They exercise a very remarkable power over organic substances, especially those which are complex in chemical constitution, resolving them into simpler combinations. Owing to this property, some bacteria are of great economic value, and without their agency many of our industries could not be pursued; others again, and these are the most talked of, exercise a malign influence in the production of the most deadly diseases which afflict man and the domestic animals.

Great attention has been given to the structure of bacteria and to their mode of propagation. When examined in the living state and magnified about 2,000 times, a bacterium appears as a homogeneous particle, with a sharp definite outline, though a membranous envelope or wall, distinct from the body of the bacterium, cannot at first be recognized; but when treated with reagents a membranous envelope appears, the presence of which, without doubt, gives precision of form to the bacterium. The substance within the membrane contains granules which can be dyed with coloring agents. Owing to their extreme minuteness, it is difficult to pronounce an opinion on the nature of the chromatine granules and the substance in which they lie. Some observers regard them as nuclear material, invested by only a thin layer of protoplasm, on which view a bacterium would be a nucleated cell. Others consider the bacterium as formed of protoplasm containing granules capable of being colored, which are a part of the protoplasm itself, and not a nuclear substance. On the latter view, bacteria would consist of cell plasm inclosed in a membrane and destitute of a nucleus. Whatever be the nature of the granule-containing material, each bacterium is regarded as a cell, the minutest and simplest living particle capable of an independent existence that has not yet been discovered.

Bacteria cells, like cells generally, can reproduce their kind. They multiply by simple fission, probably with an ingrowth of the cell wall, but without the karyokinetic phenomena observed in nucleated cells. Each cell gives rise to two daughter cells, which may for a time remain attached to each other and form a cluster or a chain or they may separate and become independent, isolated cells. The multiplication, under favorable conditions of light, air, temperature, moisture and food, goes on with extraordinary rapidity, so that in a few hours many thousand new individuals may arise from a parent bacterium.

Connected with the life-history of a bacterium cell is the formation in its substance, in many species and under certain conditions, of a highly refractile shiny particle called a spore. At first sight a spore seems as if it were the nucleus of the bacterium cell, but it is not always present when multiplication by cleavage is taking place, and when present it does not appear to take part in the fission. On the other hand, a spore, from the character of its envelope, possesses great power of resistance, so that dried bacteria, when placed in conditions favorable to germination, can through their spores germinate and resume an active existence. Spore formation seems, therefore, to be a provision for continuing the life of the bacterium under conditions which, if spores had not formed, would have been the cause of its death.

The time has gone by to search for the origin of living organisms by a spontaneous aggregation of molecules in vegetable or other infusions, or from a layer of formless primordial slime diffused over the bed of the ocean. Living matter during our epoch has been, and continues to be, derived from pre-existing living matter, even when it possesses the simplicity of structure of a bacterium, and the morphological unit is the cell.

(To be continued.)

INDIAN COAL.

A NOTEWORTHY discovery of coal on the property of the Bengal Coal and Iron Company was announced lately. Other finds have since been reported from various parts of India, the most important being that referred to at the recent annual meeting of the Nerbudda Coal and Iron Company. It is estimated that this particular deposit contains 10,000,000 tons of good quality fuel—not a prodigious quantity, certainly, but still sufficient to represent a respectable accession to the reserves of the company. These discoveries of coal in various districts of India are of interest to the United Kingdom in two or three ways. They must help to solve the whole question of India's ability to cultivate a large iron manufacturing industry. One of the principal deterrents hitherto to any considerable development in this direction has been the lack of suitable coal in quantities large enough to insure a continuity of supplies. We do not know much that is scientifically definite on the subject of the recent discoveries, and it is quite possible that they may be no better adapted than the bulk of that already produced for the purpose of iron manufacture. On the other hand, finds are so numerous, and are being made in so many widely-scattered districts of the empire, that there is every likelihood before long of some one unearthing big deposits of good cokable coal. In the meantime, it is to be noted that the Nerbudda Company expects great profit from its new seam, for it is to be well understood not that fuel of the right sort is not obtained in India, but only that at present there is no great quantity of it available; and the Indian iron industry could not possibly make strides even in the Indian markets if it had a mind to depend upon the United Kingdom for the necessary coal. The increase of production in the dependency is in another way of very direct interest to us at home, for it implies a decrease in the imports of steam coal for railway and factory consumption. Every ton mined is used up, and were double the quantity obtainable, there would be little difficulty in disposing of it. For though in steaming qualities Indian coal is poor enough, as compared with that of South Wales, it is possible by the adaptation of furnace bars to use it with good results; and allowing for its initial inferiority, there is a great saving in fuel bills by its employment. The reason for this is quite clear. The chief colliery districts are not very remote from the centers of industrial consumption, especially Calcutta; they are in communication with railways, and what may not be used by the railways is snapped up eagerly by the mills. It is the misfortune of not a few localities where coal occurs in great profusion that they have not yet been brought within the network of railway lines that is gradually spreading over the whole of India. The remedying of this defect is a matter for the future, near in some cases, and rather remote, we are afraid, in some others. But we have much hope that private capital will, on the proper establishment of a gold currency in the country, be induced to supplement the official endeavors. The government, however, might do something toward aiding the development of the mineral resources, and especially the carboniferous resources of the country.

The present output is in excess of 5,000,000 tons per annum, as compared with 3,537,000 tons in 1895, and less than 2,000,000 tons in 1889. The improvement in the decade is respectable, and would have been greater had the facilities been better. It is only in Bengal that these facilities are at all fair, and this accounts for the fact that that province takes credit at present for about three-fourths of the total for the whole country. Next in importance to it, but a long way behind, comes the Nizam's Territory, which boasts the Singareni Colliery, on the Yellandu field, where coal is estimated to be so plentiful as to be capable of supplying the needs of all the railways of India for the next 100 years. Assam, the Central Provinces, Punjab, Central India, Burma, Baluchistan, and other parts contribute to the annual output in fair proportion, and are each and all capable of much better things if only the disabilities were removed and communication given between the mines and the consuming centers. At present, and because the means of communication are imperfect, some districts are dependent almost entirely upon the requirements of the one particular railway which taps them. Thus, the Shahrigh, Khost, Dandot, and Bhaghanwala collieries are worked in connection with the North-Western State Railway. It would be possible, we know, to make too much of the country's future in this matter of coal, especially as the limitations on the basis of discoveries to date are quite clear. But that there is considerable room for the growth of a great home trade will probably be allowed without much dissent.—The Mining Journal.

COMMERCIAL RELATIONS BETWEEN THE UNITED STATES AND SPAIN.

COMMERCIAL relations between the United States and Spain have been fully restored. The figures of the Treasury Bureau of Statistics for the fiscal year 1900 show that the exports from the United States to and imports into the United States from Spain in the fiscal year 1900 were larger than in any other year since 1893, and within a few hundred thousand dollars of the highest record ever made in the commerce between the two nations. Exports from the United States to Spain in the fiscal year 1900 were $13,399,680, against $10,912,745 in the fiscal year 1897, the last full year preceding the war, while the imports into the United States from Spain in 1900 were $5,950,047, against $3,631,973 in the fiscal year 1897. The only years of the decade 1890-1900 in which the commerce between the two nations was as large as in the year just ended were 1891, 1892 and 1893, when the exports to Spain averaged about $13,500,000, and the imports from Spain about $5,500,000 annually. In the fiscal year 1899, which felt the full effect of the war between the two countries, the exports from the United States to Spain were $9,097,807, those of the present year thus being more than 50 per cent. in excess of that year; while our imports from Spain in 1899 were $3,982,363, against $5,950,047 in the fiscal year just ended.

Cotton, breadstuffs, mineral oils and manufactures of wood are the principal articles of our exports to Spain, raw cotton being by far the largest single item in the list. Fruits, nuts and wines are at present the largest items of our imports from Spain, though in earlier years iron ore formed an important item of our importations from Spain.

Importations of iron ore from Spain have also increased in the year 1900 as compared with years immediately preceding, amounting to $645,279, against $44,648 in 1899 and $302,327 in 1896, though in the years 1890 and 1891 our importations of iron ore from Spain amounted to nearly $1,000,000 annually. The principal importations of fruits from Spain are almonds, oranges, and raisins, while of almonds the importations average nearly a half million dollars annually, and of raisins from a half million to one million dollars per annum.

In exports, by far the largest item is unmanufactured cotton. The exportations of cotton to Spain from the United States were, in 1890, 87,669,782 pounds, and in 1900 were 121,846,155 pounds. This particular feature of our export trade with Spain was not materially affected by the war, the quantity of cotton exported from the United States to that country in the fiscal years 1898 and 1899 being higher than in any other year during the decade, though the number of pounds exported to Spain in 1900 is but slightly below that of 1899, while the increased price per pound brings the value of this single item of our exports to a higher figure than in any other year of the decade ex-

cept 1891. The total value of raw cotton exported to Spain from the United States in 1900 was $9,481,700 out of a total of $13,399,680, representing the value of all articles exported to Spain from the United States. Next in importance is wood and manufactures thereof, the most important item under this head being shooks, staves and headings, of which the exports to Spain have averaged considerably more than a half million dollars during the decade. Next in importance to cotton and manufactures of wood is provisions, of which the exportations to Spain are controlled largely by crop conditions in that country, the total for 1899 being $518,088, against $80,344 in 1898 and $1,941,206 in 1893.

ROMAN AND GALLO-ROMAN FLOUR MILLS.

At a time when the roller is nearly everywhere replacing the millstone, the fixing of the origin of this primordial apparatus of human alimentation is not without interest. This has just been done by M. L. Lindet in utilizing, in part, the notes that M. Aimé Girard has been gathering for many years, and, in part, certain original documents collected by himself. From this work, which is remarkable by the abundance and accuracy of the data presented, we borrow that portion which concerns Roman and Gallo-Roman flour mills.

In the first place, the royal people made use of flat stones hollowed out near the center, and other stones having the same form and size as the hollow part of the preceding and serving for braying the grain. This process was the one most anciently employed, and stones of this kind have been found in a large number of lacustrian stations, caverns, and cities of the neolithic epoch, and in the excavations of Mycenæ, Troy, etc. Fig. 1 represents a very curious group discovered in Greece and now belonging to the Museum of the Louvre. It comprises four individuals, male or female, occupied in maneuvering an object which may be either a fragment of dough or of potter's clay, or else a stone designed for braying grain. A flute player, standing alongside of them, is entertaining and animating them in their arduous labor.

There have been likewise exhumed from Egyptian tombs some statuettes representing women sitting squat in front of flat stones provided with their grinders; and, in a bas relief of the palace of Khorsabad, we see some women who seem to be engaged in the same occupation.

The mortar was employed concurrently by the Romans and the Greeks, the latter of whom frequently figured upon their vases women in the act of braying. The pestle was actuated by a large wooden lever, and in this way was effected the crushing of the grain that was afterward to be submitted to the action of the grinding stone.

But these primitive processes could scarcely render any service except in domestic practice. As soon as denser agglomerations brought about the creation of trades properly so called, it became necessary to provide apparatus for giving a larger production.

The mill with a revolving upper millstone responded to such a need. This, probably devised by the Greeks, but seemingly not very widely employed, was mentioned for the first time by Cato, two centuries before Christ. It was a question only of apparatus actuated by slaves or asses. A century later on, Strabo, Lucretius, and Vitruvius speak of mills operated by water, and in which, evidently, only revolving stones could have been employed. We shall return to these further along.

"The best of the documents," adds M. Lindet, "is the existence, amid the ruins of Pompeii, of Roman mills in situ, some of which might be operated to-day. These were found either in private houses (Casa Labirinti) or in industrial bakeries (Casa di Marte e Venere and casa di Sallustio)." They are represented in Fig. 2. The revolving mill (catillus) consisted of two conical parts, the upper one of which received the grain, while the lower one covered the stationary millstone (meta). This latter was provided with oblique grooves designed to direct the ground product. These grooves ran from left to right, in the direction in which the catillus revolved.

Numerous bas reliefs, moreover, confirm the existence of this apparatus. Figs. 3 and 6 reproduce bas reliefs of the Chiaramonti Museum, in which are seen two mills, one of them actuated by a horse and the other by an ass. In the first are plainly seen the grooves upon the millstone, and beneath both of them are observed the troughs designed for the reception of the flour.

In the constricted part of the catillus, and externally, were fixed two hollow center pieces of rectangular section for the reception of wooden levers, which were secured by pins of the same material. The millstones, of which the specimens collected vary in diameter between 20 and 40 inches, were of considerable weight, and it was necessary, both from the viewpoint of setting in operation and of modifying the spacing according to the fineness of the product to be obtained, to suspend the upper one. The most practical process consisted in fixing to the summit of the meta (see cartouche in Fig. 2) a vertical iron rod, *B*, which engaged at its upper extremity with a transverse piece of wood, *A*, in which it was held by a pin. The spacing was probably regulated by means of apertures formed in the rod. The transverse piece was connected with the horizontal maneuvering levers by two oblique pieces, *C C*, pinned with them in the lateral hollow center pieces.

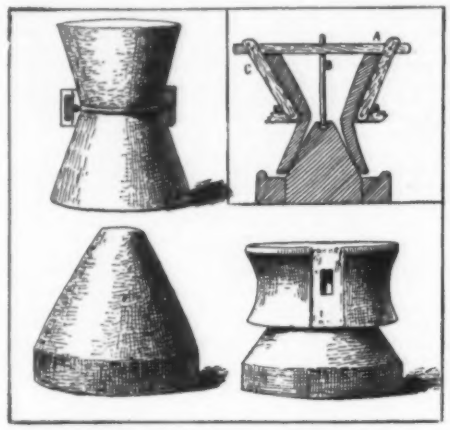


Fig. 2.—MILLS FOUND AT POMPEII.

The bas relief shown in Fig. 3 is provided with a hopper, and it is reasonable to suppose that the cord that projects from it is that of a valve that was maneuvered at the moment at which the proper rotary velocity was reached. As for the bas relief in Fig. 6, that shows us, already in use, the signal bell of our present flour mills.

Unfortunately, none of the bas reliefs furnishes the complete arrangement of the harness. The horse to the right in Fig. 3 carries, it is true, a collar connected through a chain with the upper cross piece, and not with the central lever, although that of the animal to the left is provided with a sort of hook. It is doubtful, however, whether it could have been thus in reality, for the circle described by these animals would have been of very small radius and the force required not in keeping with the weight of the large catilli.

M. Lindet thinks that this kind of flour mill was the one most widely employed. It is not proved that revolving mills were known in Gaul at the time of the Roman invasion, and it seems natural to admit that they were imported upon this occasion. However this may be, the dimensions of the apparatus were sensibly diminished and it became portable. Moreover, the upper part of the jacket was suppressed and the lateral center pieces of the model of Pompeii were reduced here to two lugs that necessitated the mortising of the maneuvering levers. Fig. 4 represents two catilli of Roman mills that served thus as a transition.

As for the Gallo-Roman millstones, Fig. 5 gives various types that differ but slightly from each other, and the characteristic of which consists in the slight projection of the lower stone in the center, a form much more rational than in the Roman apparatus, since it permits the grain to remain longer between the grinding surfaces. Sometimes the millstones were grooved on the surface in lines running in the direction of the radii. Fig. 5 represents a millstone of the Saint Germain Museum in which the grooving may be compared to that which is adopted at present. The grain was introduced through an aperture formed in the upper millstone. The stone was suspended through a cross-piece and a vertical rod analogous to those of the apparatus shown in Fig. 3. To effect the rotation, a bar fixed to the side, either in a horizontal or vertical position, was employed. This process is that which we now find among peoples of low civilization.

Fig. 6.—MILL ACTUATED BY AN ASS.

The Greeks and Romans did not utilize the motive power of the wind, or at least Vitruvius does not speak of it. On the contrary, he describes the water mill, such as we know it to-day. "Upon the horizontal axle of the float wheel," says he, "there is a cog wheel that revolves along with it. This vertical wheel gears with another arranged horizontally, and larger than the first, that gives the millstones a circular motion." Strabo mentions one that was seen at Cabiras, near the palace of Mithridates; and these different texts show that the ancients were acquainted with water wheels as far back as the first century before Christ. They rapidly multiplied, especially in Italy, in the fourth and fifth centuries, and were established not upon large and small rivers (doubtless on account of the difficulty of constructing sufficiently strong wheels), but upon brooks and aqueducts. Nevertheless, at the siege of Rome in 537, Vitiges, king of the Ostrogoths, having cut off the water of the aqueducts that supplied the flour mills, Belisarius "attached two cables to the banks of the Tiber, below the bridge, and held therewith two large boats at two feet distance from each

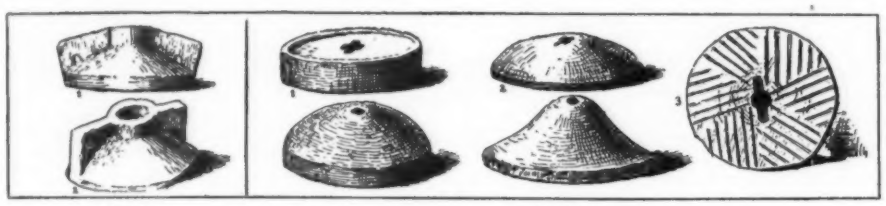


Fig. 4. Fig. 5.

Fig. 4.—CATILLUS OF ROMAN MILLS.
1. Museum of Chambery. 2. Borely Museum.

Fig. 5.—GALLO-ROMAN MILLSTONES.
1 and 2. Fabre and Royat Collection. 3. Saint Germain Museum.

Fig. 1.—GROUP OF GREEK INDIVIDUALS OCCUPIED IN CRUSHING GRAIN.

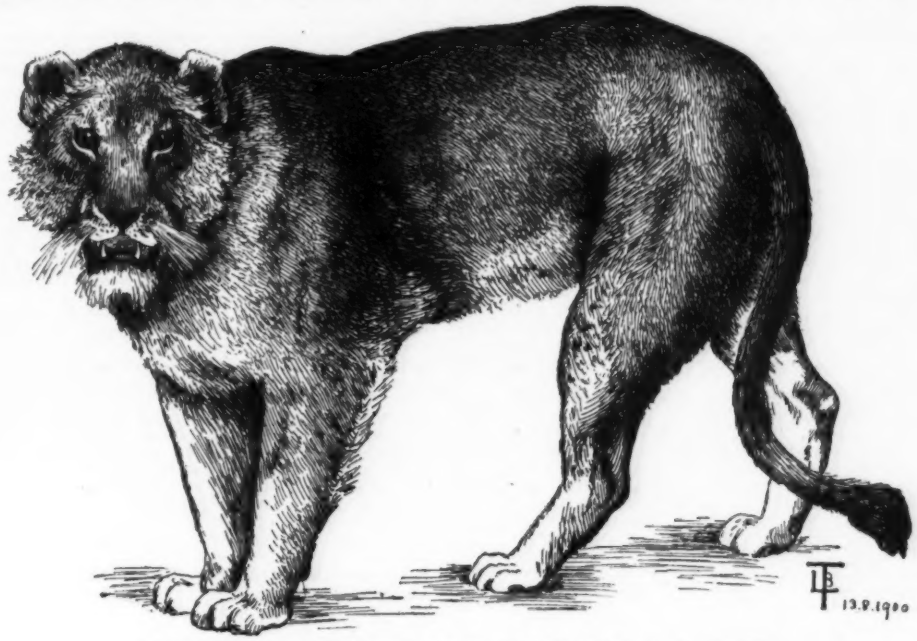
Fig. 3.—FLOUR MILL ACTUATED BY A HORSE.

other at the place where the water makes its exit with the greatest violence from beneath the great arch. Then he placed mills upon the edges of the two boats and set up the engines that were to cause them to revolve." *

It will thus be seen that it was a question of overshot wheels in the case of aqueducts and of undershot ones in case of natural water courses.

Here ends, properly speaking, the part that we have thought it well to borrow from M. Lindet's interesting work. It shows that with the invention of the revolving millstone and of the float wheel as a motive apparatus, the constituent elements of flour mills other than those driven by wind were already in current use as far back as the beginning of the Roman empire. There nevertheless remained a long stride for them to make before reaching their present state. In the concluding part of his memoir, our author shows how the application of mechanical processes to the rotation of the flour mill increased its velocity and caused the smoothing of the stones. The centrifugal force, in fact, had become sufficient to drive the grain which had previously slid over the meta almost solely under the action of its own weight. The grooving adopted led also to the same result, since it tended to give the grain the necessary direction. Finally, since the grooving gave the stones a "biting" character, it became possible for the milling industry to utilize harder stones, and since it was difficult to find any that were homogeneous upon their entire surface, it became customary to construct them in pieces or "panes." This at the same time favored the increase in diameter and extent of the production.

Such is the Odyssey of these valuable apparatus, the history of which is nearing its end, since they have now, in all important installations, given way to those roller grinders which characterize every modern flour mill.—La Nature.



KRUGER'S LIONESS, NOW AT THE ZOOLOGICAL GARDENS.

The lioness presented by Mr. Rhodes to Mr. Kruger, and declined by the president, has now arrived at the Zoological Gardens and is attracting many visitors. The lioness has not had her tail shortened, as report averred, but her ears have been trimmed.

ROUPELLIA GRATA.

THIS is a stove climber rarely seen in gardens, but when it is seen it commands admiration; flowers creamy white, rose-tinted, deliciously fragrant. The plant is a native of Sierra Leone, and is said to produce the fruit called cream-fruit, though this point is, we believe, uncertain. We have seen it in flower at Kew, and specimens were exhibited in the spring of the year at the Royal Horticultural Society. It belongs to the Apocynaceæ, which furnish many ornamental species to our gardens.—The Gardeners' Chronicle.

ASHANTI FETISHES AND ORACLES. †

THE Ashantis recognize the existence of a Superior Being, whom they adore, but in a vague manner. . . . At the commencement of the world, in the night of time, Onyame (God) was in daily relations with men. He came on the earth, conversed with mankind, and all went well; but one day the women, in pounding their fufu, used too long pestles and struck God, who in anger retired from the world, leaving its management to subaltern divinities. These are spirits (fetishes) who dwell everywhere, in waters, woods, rocks, and it is necessary to conciliate them, unless one is willing to encounter their displeasure. Hence the worship rendered to fetishes. Let us take a concrete example, and see how things pass when one goes to consult the fetish Deute at Krakye, the most known and most powerful on the Gold Coast. This fetish is served by two priests. One lives in public and is well known, while the other remains concealed, is known to nobody, and considered as the great priest of the fetish. For the rest, all the inhabitants of Krakye are affiliated to the fetish, and labor to augment his prestige and renown. If a stranger arrives in the town to consult the fetish, he is made to talk, interrogated; information is obtained concerning the object of his journey, his family circumstances—all this without display; and these details, it is unnecessary to say, are carefully communicated to the priest, who derives from them all possible profit. In the night, when all the world is asleep, he goes to find his secret companion, relates to him all he knows, and prepares with him the séance of the morrow. In fact, it is not possible to interrogate the fetish every day; monsieur has his hours of consultation, and that but once a week. He inhabits a great cavern, in which during the day is kept his secret priest, and thither come the people to consult him under the direction of the public priest.

Atia-Yaw, the most important fetish of Okwaou, was known and feared for leagues about. Up to the time of the arrival of the missionaries none contested his power, none had the idea of doubting his existence and potency. Some affirmed that he was a spirit; others saw in him an animal. These last, for a period, were right; it was said that during several successive years a gorilla played the part of the fetish. In fact, no one had seen him, none had touched him, except the king or the chiefs, to whom at times he extended a little hand, hairy and unrecognizable, without revealing himself. This divinity also lived in a cave, where he gave responses after the manner of Virgil's Sibyl. . . . . Atia-Yaw did not remain confined in his cavern; he allowed himself promenades. Preceded by a forerunner, who announced his approach by means of a shrill whistle, and cried, "Here is the father!" he traversed the town in every direction, and woe to those who encountered him! A stab, a shot made them comprehend that it is never well to be curious. He generally arrived at the fall of night, between half-past six and seven in the evening. At such time every one fled into his house and put out his fire, for it was supposed that the fetish could not bear fire. At other times he took malignant pleasure in chasing the inhabitants out of the city to dung-heaps, where they became the victims of the ants constantly found there. He presented himself under all sorts of forms. Sometimes he came furious, and made every one tremble; sometimes he tranquilly promenaded the streets, even presented himself before the king and discussed politics, naturally always through the medium of his priest.

* Procopius, De Bello Gothico.

† Journal of American Folklore.

[Continued from SUPPLEMENT, No. 1291, page 20702.]

CHEMICAL AND TECHNICAL EDUCATION IN THE UNITED STATES.*

By Prof. C. F. CHANDLER, Ph.D., M.D., LL.D., D.Sc. Oxon.

OUR CHEMICAL SOCIETIES.

OUR chemical societies have already accomplished a great deal that has benefited and consolidated the profession in America.

The first step in the movement was the suggestion, early in 1874, by Prof. H. Carrington Bolton, that that year might be very properly regarded as marking the beginning of modern chemistry, and suggesting that the chemists should meet and enjoy a social reunion in commemoration of events important alike to science and civilization. It was a woman, Miss Rachel L. Bodley, professor of chemistry in the Women's Medical College at Philadelphia, Pa., who had the happy thought that this reunion should take place at the grave of Joseph Priestly in Northumberland, Pa., where he found an asylum, when compelled to leave England, and where his grandchildren still live. The idea was very cordially received, and on August 1, 1874, the 100th anniversary of the discovery of oxygen, the chemists of the United States and Canada met at the grave of Priestly to celebrate the centennial of chemistry. The convention lasted for three days and was full of interest. The success of this movement led soon afterward to the creation of the American Chemical Society, which was organized under a charter from the State of New York, and I had the pleasure of nominating for first president of this society an Englishman, John W. Draper, who was duly elected. This society has grown in influence and importance, until at the present time it has 1,544 members. Following the example of the Society of Chemical Industry, it began a few years ago to organize sections in different parts of the country, of which there are at present eleven in successful operation.

As you are well aware, early in 1895 your council authorized the establishment of a New York section of the Society of Chemical Industry. We are chiefly indebted to the late Mr. Mason, who became the first chairman of the section, and to my predecessor, Mr. Tyrer, for initiating the movement which led to this result. This section has grown with great rapidity, and at the present time there are 738 members of the society resident in the United States, most of whom have enrolled themselves as members of the New York section. There was some fear when the section was first established that it might interfere to a greater or less degree with the interests of the American Chemical Society, but our fears in this respect proved groundless, and I think I may fairly say that the interest manifested in the section has tended to consoli-

ROUPELLIA GRATA—FLOWERS CREAM-COLORED, FLUSHED WITH ROSE.

* Read at the nineteenth annual general meeting of the Society in London, in the theater of the Royal Institution, Albemarle Street, on Wednesday, July 18, 1900, Prof. C. F. Chandler, President of the Society, in the chair.

date the chemical profession and to stimulate activity among its members, and has really been of great advantage to the American Chemical Society.

Good fellowship among the chemists has been so much promoted by these societies that we have recently ventured to establish a chemists' club in New York city. We have secured ample accommodation and a sufficient number of resident and non-resident members to cover the actual expenses of operating the club. We have recently entered upon our second year with 139 resident members and 103 non-resident members. We have a large lecture hall entirely our own, and the American Chemical Society and the New York section of the Society of Chemical Industry hold their monthly meetings there. It is our ambition to make this chemists' club the headquarters for chemists throughout the United States, and our special mission is to supply chemical literature and information to the members. We are undertaking to establish two complete chemical libraries, one for reference to be retained permanently at the club, and a duplicate library for circulation throughout the country, and we propose to have one or more chemists regularly employed at the club to select books and to send them to members on demand, and to supply information of every kind, so that a chemist living in some small rural town, perhaps thousands of miles away from New York, having occasion to inform himself upon some chemical subject, may write to the club and be supplied with all necessary references and necessary books. To do this work properly, we shall certainly need at least 1,000 members, but our success so far is such that we feel satisfied that we shall be able ultimately to accomplish all that we hope in this direction.

You have at the offices of the society the nucleus of such an enterprise in the chemical library of the late Walter Weldon.

CHEMICAL RESEARCH.

American chemists have been constantly engaged to a greater or less degree in original investigation, and did time permit I could present a long list of valuable contributions to chemical science which have come from American laboratories.

It is a fact, much to be regretted, however, that many of our teaching chemists are so overburdened with the duties of instruction and the business of managing large laboratories that they find but little time for private investigations.

There are, however, notable exceptions, and none more striking than is found in the work of Prof. Morley, the recent President of the American Chemical Society, who has found time to devote a marvelous amount of patience, ingenuity, and skill to his classical investigation of the densities of oxygen and hydrogen. It would be invidious, however, to point out special names from among our chemists, without doing justice to all, and I will confine myself to the work of the fortunate chemists who are able to devote all or the greater part of their energy to investigation.

THE UNITED STATES AGRICULTURAL DEPARTMENT.

Most important investigations in agricultural chemistry have been conducted by the chemical division of the United States Agricultural Department under the direction of the chief chemist, Harvey W. Wylie. Perhaps the most interesting of these investigations has been the establishment of methods for determining in a practical way the number and activity of the nitrifying organisms in soil. Since the discovery of the fact that these organisms supply to plants the nitrogenous foods which they need, and of the value of nitric acid, it has been evident that a new method of soil analysis must be devised in order to keep in touch with this progress in knowledge. To accomplish this purpose, a method of securing samples of soil in sterilized tubes was devised, and these samples have been received from all parts of the United States. A systematic study of the number and character of their nitrifying organisms has been made under standard conditions. It has been shown that the fertility of the soil depends more largely on the character of the nitrifying organisms which it contains than has been generally supposed. The condition of sterility which has often been found in vegetable soils is due to the development of acids by decaying organic matter. In this case the addition of lime produces a favorable result generally, by neutralizing the acidity of the soil and by restoring a proper environment in which the nitrifying organisms can thrive.

An interesting research has been carried on in this connection in regard to the availability of the natural mineral phosphates in a fine state of subdivision. Extravagant claims of dealers in these goods have been made, to the effect that they are fully as efficient as acid phosphates, or as phosphoric acid in the basic phosphatic slags. In the researches conducted by the Department of Agriculture, it has been shown that the finely ground mineral phosphates are quite as efficient in the extremely acid vegetable soils known as "muck," as the other forms of phosphoric acid, but in ordinary soils, where there is no undue acidity, the natural mineral phosphates produce very little effect at first and decompose very slowly.

The influence of a soil rich in nitrogen on the nitrogen content of a crop has been the subject of an interesting investigation. It has been found that oats grown in a vegetable soil containing an average of two per cent. of nitrogen show an enormous increase in the total nitrogen in the crop itself. On investigation as to the form in which the nitrogen exists in this crop, however, it was found that protein nitrogen was not notably increased, but that almost the total increase in the nitrogen had been in the amid form, the crop containing enormous quantities of nitrogen in this form of combination.

The difficulties of successfully manufacturing sugar from sorghum have been long recognized, and it has been a matter of surprise that a plant containing so high a percentage of sucrose should yield so small a quantity of crystallized sugar. It was found that the cause of this was due chiefly to the enormous quantity of starch and gums, of different kinds of carbohydrates, which the sorghum plant contained. Many attempts were made to free the sorghum juice from these objectionable matters, but only one was attended with success. It was found that when sorghum juice can be evaporated to a sirup consistency, to 30° Baumé, and then treated with an equal volume of 95 per cent. alcohol, and the sirup thus completely freed from the starches, dextrine, gums, etc., that a satisfactory yield of sugar can be secured. The precipitated matters are separated by a filtering press, and the alcohol in the sirup recovered by distillation and used again. In this way it was demonstrated in a practical manner that the sorghum will yield the complete complement of sugar, more than 200 pounds per ton of fine crystallized sugar having been obtained.

Another important matter developed by this research was the fact that the gums and other separated matters can be completely converted into alcohol by fermentation; thus the waste matter in this process was found to yield all the alcohol necessary to replace the unavoidable losses during the manufacture. This research, which was completely successful from a practical point of view, failed only in application because it was found impossible to secure the necessary fiscal legislation to permit the use of alcohol free of tax in this art.

The study of the conditions under which the highest grade of sugar beets can be produced in the United States has been one of the most important researches conducted by the division of chemistry. These researches have led to the mapping out of the districts where the soil and climatic conditions are most favorable. The first attempts in the United States to construct agricultural maps showing the distribution of areas favorable for specific purposes was accomplished by these investigations. These researches have now been practically completed, and are of such value that all intending investors in the sugar beet industry are guided by these results in the locating of their factories.

Extensive investigations have been carried out in regard to the influence of soil and climate on the composition of cereals. These have been especially useful in connection with the gluten content of wheat. In many of the States of the Union it has been found that in a few years wheat which at the beginning had contained from 10 to 12 per cent. of dry gluten, had so deteriorated in quality as not to yield more than 6 per cent. The conditions which have produced this deterioration have been carefully studied, and steps have been proposed to remedy the evil. These investigations are still in progress, and will probably not be completed for many years.

A comparative study of the typical soils of the United States has been the subject of a recent extended research by the chemical division. Soils are obtained from many localities, even from the celebrated agricultural experiment station at Rothamsted in England. These soils have been subjected to absolutely the same conditions and the same treatment, and the crops which have been produced have been carefully examined. All of the soils have been carefully subjected to analytical treatment by standard methods, with the object of determining the methods corresponding most nearly to the actual crop results. Data of the most interesting kind from a practical point of view have been secured as a result of these investigations, and soil maps are now being prepared for publication.

A study of the influence of feed and environment on the composition of milk and butter has been carried on in a very extensive way. It was through the researches of this division that the influence of cotton-seed meal as a food upon the melting point of butter was first pointed out. Strange as it may seem, the feeding of milch cows with cotton-seed meal produces a butter which has a higher melting point than butter produced by the ordinary foods. Thus, where this food grows in abundance, the tendency is to produce a better butter suited to the high temperatures of the southern parts of the country.

In analytical methods many experiments have been made by the Division of Chemistry, and many new methods established: the standard methods of determining the melting point of butter now [used ,throughout the United States is an illustration.

The apparatus for extracting with ether, using a mercury seal alone without any corks or other stoppers, a very useful invention, was originated by the Division of Chemistry.

The method of using bromine for separating nitrogenous matters in meats, originally devised in England, has been applied with many modifications in the analytical work of the Division of Chemistry with the greatest success.

There is neither the space nor the time to go into detail in regard to these matters, but they are found in numerous scientific papers which have been issued by the Division of Chemistry during the last 15 years, numbering more than 150 and covering every branch of agricultural and chemical investigation. The principal work of the Division of Chemistry has been published in bulletins, 60 of which have already appeared, offering a literature invaluable to agricultural research chemists in all parts of the world.

Careful and systematic research has been made by the chemist of the Agricultural Department with regard to the use of preservatives in articles of food and drink, and the position of the Department is well illustrated by the following paragraph from his report:

"It is not regarded as a wise thing to absolutely prohibit the use of preservatives in food; since, however, all chemicals which have the properties of preserving foods also have a tendency to interfere with the process of digestion, it is held to be imperative that no food shall be offered for sale which contains a preservative without having this fact plainly stated on the label of the package. Not only should the label state that the food product contains a preservative, but it should also give the name of the preservative and the quantity employed. In this way the intending purchaser is fully informed in regard to the character of the product which he buys. While it has been established that a healthy stomach can, from time to time, receive with impunity food containing a small quantity of preservatives, it is by no means certain that the continued practice of ingesting preservatives in the foods would not produce serious injury. On the other hand, it is also quite certain that weak or diseased stomachs may suffer temporary or permanent injury from even minute quantities of preservatives."

I should not do complete justice to the Department of Agriculture did I not refer to the work of the Bio-Chemical Division, in charge of Dr. E. A. v. Schweinit. The poisons, proteid and basic, produced by hog cholera and swine plague germs were carefully studied, and it was found possible to isolate them in a fairly pure form and use them for the purpose of producing immunity to these diseases in small animals. The first work in the United States in connection with the preparation and study of tuberculin and mallein was carried out at this laboratory, and the general introduction of these two agents as a means of diagnosis was brought about by the Bureau of Animal Industry. Since 1892 there have been prepared and distributed to State inspectors both tuberculin and mallein, to be used in connection with general Board of Health work and for the purpose of suppressing and exterminating these two diseases in animals.

The proteid poison produced by the glanders germ, which is the cause of the characteristic reaction produced by mallein in glandered animals, has been carefully studied and its use as a corrective agent has been experimentally noted.

The first work in the production of an anti-toxine serum for hog cholera and swine plague was carried out experimentally in this laboratory in 1892, and in the same year, as the result of a series of experiments, a soluble ferment was discovered in a minute amount in the cultures of the hog cholera germ and the relation of this enzyme to immunity was demonstrated. During the past three years anti-toxine serum for both hog cholera and swine plague have been prepared on a large experimental scale with very satisfactory results.

Very careful analysis of the cultures of tubercle and other bacilli, more especially in connection with the tubercle bacilli, have been made. The study of the fatty matter contained in tubercle bacilli and the isolation from the tubercle bacilli of the proteid poison and the necrotic acid, which seem to be of the utmost importance in the progress of tuberculosis in the animal body, have also been accomplished. A careful analysis of the ashes of the tubercle bacilli has also demonstrated many important points.

I may be pardoned for calling attention to the fact that this work upon the fats of the tubercle bacilli was finished and published more than a year before the German and French investigators paid attention to the matter.

Considerable time has been devoted to the possibility of producing anti-toxine serums for tuberculosis, and the artificial medium which was recommended for bio-chemical investigation in the year 1893 has been of great value in the study of the products of the different germs referred to, as well as of others.

One of the most important services rendered by the Agricultural Department to the chemical profession has resulted from the formation of an Association of Official Agricultural Chemists, which has now been in existence for many years. This association has made it its especial duty to carefully study all the methods of chemical analysis applied to fertilizers, foods, soluble carbo-hydrates, dairy products, fermented and distilled liquors, soils, plant ashes and tanning materials. Standing committees are appointed, among which are distributed the various topics. All the old methods have been diligently tested and compared, and many new methods have been devised. The results of these studies and experiments are embodied in an Annual Report published by the Department of Agriculture on the methods of analysis adopted by the Association of Official Agricultural Chemists. This report is edited by Prof. Wylie, and is a masterpiece of careful and critical investigation.

THE AGRICULTURAL EXPERIMENT STATIONS.

The example set by your countrymen, Lawes and Gilbert, in the noble work which they have accomplished at Rothamsted during the last half century, has led to the establishment in the United States of agricultural experiment stations all over the country, and a large amount of original investigation in subjects more or less allied to agricultural and physiological chemistry has been accomplished at these stations, of which there are now 59.

There are 148 chemists connected with these experiment stations, all devoting their entire or chief attention to chemical work. One of the most important objects in view in establishing these stations was to protect the farmer from the cupidity of the dealers in artificial fertilizers. Every fertilizer sold in the United States is now subject to careful chemical analysis, and the results are published in the bulletins issued from time to time by the stations. Not only is the exact chemical composition of the fertilizer given, but the station from time to time fixes the commercial value of the important constituents of fertilizers, and in the report of the analysis attaches to each its commercial value based upon the standards adopted.

The amount of money which has been saved to the farmers by this work alone is incalculable. It has been extended to the analysis of feeding stuffs and foods. A large amount of work has been done by the station chemists on methods of agricultural analysis, working independently and in co-operation with the Association of Official Agricultural Chemists. This work has had an important bearing on the evolution of methods of analysis, in securing uniformity, and in reducing errors.

The accompanying table is an example of such a standard of values.

TRADE VALUES OF PLANT FOOD ELEMENTS IN RAW MATERIALS AND CHEMICALS, 1899.

	Cents per Pound.
Nitrogen in ammonia salts	15
" in nitrates	12½
Organic nitrogen in dry and fine ground fish, meat and blood, and mixed fertilizers	14
Organic nitrogen in cotton-seed meal and castor pomace	13
" " in fine ground bone and tankage	14
" " in coarse bone and tankage	10
Phosphoric acid, water soluble	4½
" " citrate soluble	4
" " in fine ground fish, bone, and tankage	4
" " in coarse fish, bone, and tankage	3
" " in cotton-seed meal, castor pomace, and wood ashes	4
" " in mixed fertilizers, insoluble in ammonium citrate and water	3
Potash as high grade sulphate, in forms free from muriates (chlorides), in ashes, etc.	5
Potash in muriate	4½

OSBORNE'S WORK ON PROTEIDS.

As a good example of the work accomplished at the agricultural experiment stations, I may refer to the investigations of Prof. Thomas B. Osborne, which have

occupied several years. These investigations were undertaken for the purpose of gaining more definite information relating to the proteid constituents, of learning something of the various classes of proteid matter, and the properties and reactions of each, and the finding of suitable sources from which proteid matter could first be obtained proper for material for a critical study of the chemical reactions and properties of proteid matter in general.

The proteids thus studied were those of the seeds of the oat, maize, flax, hemp, castor bean, squash, Brazil nut, wheat, kidney bean, cotton seed, rye, barley, pea, vetch, blue lupin, yellow lupin, sunflower, adzuki bean, cow bean, lentil, horse bean, soy bean, and also the proteids of the potato tuber and hens' eggs.

In this study the characters of the many proteids previously described were more precisely defined, and at the same time many new proteids were discovered. The following list gives those to which Prof. Osborne has applied specific names, those in italics being new proteids, those starred being proteids to which new names were given, because they were either previously imperfectly described, or else stated to be identical with others from which they were found to differ. The others had been already described more or less accurately:

Avenalin	Oats	Globulin crystallized.
Zein	Maize	Glutenoid.
Mongin	"	Globulin.
Edestin*	Hemp, squash, flax, castor bean	" crystallized.
Excelsin*	Brazil nut	" "
Glutenin*	Wheat kernel	"Cascin."
Gliadin	Wheat, rye, and barley	Glutenoid.
Leucosin*	" " "	Albumin.
Phaseolin*	Kidney and adzuki beans	Globulin crystallized.
Phaselin	Kidney bean	Globulin.
Hordein*	Barley	Glutenoid.
Tuberin*	Potato	Globulin.
Legumin	Pea, vetch, horse bean, lentil	"
Vicilin	Pea, horse bean, lentil	"
Legumelin	Leguminous seeds generally	"
Conglutin	Lupins	"
Vignin	Cow pea	"
Glycinin	Soy bean	"
Ryanin	Malt	Glutenoid.
Hyadestin	"	Globulin.

It was found that all seeds examined contained globulin, that is, proteid matter soluble in saline solutions, but insoluble in water. The globulin constitutes the greatest part of proteid matter obtainable from most seeds. From the cereal seeds but little globulin can be extracted, the greater part of the proteid matter being glutenoid, which differs from all other proteids in dissolving rapidly in alcohol from 75 to 90 per cent.

True albumins have been found only in small amount and in but few seeds, notably the cereals. Only one proteid has been recognized as properly belonging with the albumins; this is leucosin, found in wheat, rye, and barley. One other proteid, legumelin, found in all the leguminous seeds examined, should probably be classed with the albumins, but this has not been certainly established. In all seeds proteids resembling in properties and composition the proteoses produced by pepsin digestion have been found in small proportion. It was also found that in the wheat kernel the globulin, albumin, and proteose are contained chiefly, if not wholly, in the embyro. From the embryo globulin and albumin are extracted in combination with nucleic acid, as nucleo-proteids. These nucleo-proteids yield nuclein on digestion with pepsin, and have been proved to be compounds of nucleic acid with various proportions of the globulin and albumin previously obtained phosphorus free from the whole seed. These nucleo-proteids are not contained in the embryo in the form in which they are obtained from extracts of the embryo, because these compounds containing nucleic acid have various compositions, according to the conditions under which they are prepared. This is important, as it shows the nucleo-proteids to be of the same character as the compounds of protein with other acids.

The most valuable sources thus far found from which proteid matter suitable for study can be obtained are the hemp seed and the Brazil nut. From these seeds large quantities of perfectly crystallized preparations can be made with comparative ease. As a result, Prof. Osborne has been able to study critically the proteid edestin from the hemp seed, and he has found that when separated from the sodium chloride solutions the crystals consist of two forms, one of which is soluble in pure water, while the other is wholly insoluble therein. The soluble crystals have been found to be exactly twice as acid to phenol phthalein as the insoluble crystals, and to be combined with hydrochloric acid. The proportion of hydrochloric acid in the less acid compound corresponds to a molecular weight of the proteid of approximately 15,000, just twice the molecular weight calculated on the assumption of two atoms of sulphur in the molecule.

All the other products examined, including crystallized ovalbumin, are also acid toward phenol phthalein, and the conclusion seems justified that protein molecules are basic and that the acid properties which they display are due to combined acids. According to this view, they behave like the purin bases, which react with both acids and alkalies.

OTHER INVESTIGATIONS.

Other important investigations are those of Teller on proteids of the wheat kernel, and the elaboration of a method for their determination; studies on nitrogenous constituents of meats by Atwater and his collaborators; and chemical studies of butter fat by Browne. Extensive chemical studies have been made of a great variety of agricultural and industrial plants in which the composition with reference to both food and fertilizer constituents of different parts of the plant, the relation of parts and the calculated amounts of fertilizer constituents removed per acre in different parts of the crop have been determined.

Mention may be made of such studies of alfalfa, the cotton plant, cassava, maize, rice, sweet potatoes, sugar cane, sugar beet, tobacco, and wheat. Studies have been made of the composition of a wide range of feeding stuffs, natural products and by-products, the changes during growth or the result of changes during the process of manufacture. These investigations have furnished us data regarding the composition of agricultural products which are unsurpassed in extent by those of any other country.

A vast amount of work has been done by the chemists on the fertilizer requirements of plants, the availability of different forms of fertilizing substances and the means of increasing it; the demonstration of the fertilizing value of various by-products and refuse materials from manufacturing establishments, and also from natural sources, as sea weeds, marls, natural phosphates, etc.

An important line of investigation has been conducted by Wheeler, of Rhode Island, showing the true value of lime in agriculture by its effect on the nitrification of the soil, etc.

The soils of different States have been extensively studied and classified by the station chemists, and in addition investigations have been made on the relation of the humus to fertility; methods of conserving and increasing the humus, and, especially in the West, the great question of alkali in the soil has received much attention, and especially by Hilgarde, who has suggested the only practicable means of combating this increasing hindrance to agriculture under irrigation.

The chemists have frequently taken an active part in investigations relating to the introduction of new crops, or their application to new industries, and they have done a large amount of work on the improvement of plants by selection, crossing, cultivation, and other means, as, for instance, the increase of protein in the corn kernel, or tannin in canaigre, and of sugar in sorghum, sugar beets, and sugar cane.

A great deal of the most thorough work in connection with the nutrition of farm animals for the production of growth, of meat, and of milk, has been planned and executed by the station chemists. This investigation has had to do with a great variety of conditions; the determination of the digestibility of feeding-stuffs at different stages of growth, the best time for harvesting and the best methods of curing or preserving, the specific effect of different constituents of the food on the quality of the milk and on the composition and quality of the butter, the character of the meat produced on different rations, etc. Recently these investigations have been extended to problems in human nutrition, the composition of the human foods, studies of the dietaries of people in different walks of life, the fixing of standards, studies of the changes and the losses in cooking and baking foods, and similar questions.

ATWATER'S RESPIRATION CALORIMETER.

A very notable feature in connection with this work has been the elaboration and perfection of a respiration calorimeter by Prof. W. O. Atwater, in co-operation with Prof. E. B. Rosa, for the determination of the products of respiration (carbonic acid and water), and the heat eliminated under different conditions of nutrition and of labor. This apparatus is the most complete and accurate of its kind yet constructed, and has reduced the errors to those customary in laboratory determinations. It is fully described in Bulletin No. 63 of the United States Agricultural Department of August, 1899, and the results of experiments with it in Bulletin No. 69, 1899.

The principal points about the respiration calorimeter are: (1.) That it provides means for studying the metabolism of energy in the body. (2.) As an apparatus of precision it enables us to determine the quantities of carbonic acid, water and energy of the income and outgo of the body as accurately as the same determinations are made in ordinary materials by the combustion furnace and the bomb calorimeter. (3.) The experiments thus far have shown a remarkably close agreement of income and outgo of energy in the body, and thus afford a demonstration of the action of the law of the conservation of energy in the living organism.

As a respiration apparatus it is similar in principle to that of Pettenkofer. Within a metal-walled chamber 7 feet long, 4 feet wide, and 6 5 feet high, the subject lives and works during the period of the experiment, which varies from 2 to 12 days in different experiments. This chamber is furnished with a chair, table, and bed, which may be folded up when not in use. For experiments in which muscular work is to be performed there is provided also a specially arranged stationary bicycle. The chamber is ventilated by a current of air, which is drawn through it by a specially devised pump, which also measures the volume of the current and withdraws samples regularly and accurately for analysis. Samples of the air are taken both before it enters and after it leaves the chamber, and thus the products of respiration are determined. Provision is made also for passing food and drink into the chamber and removing the solid and liquid excreta. The weights and analyses of these materials, and the determinations of carbon dioxide and water in the respiratory products, give data for calculating the income and outgo of nitrogen, carbon, and hydrogen of the body.

As an instrument for measuring heat the apparatus is essentially a constant temperature water calorimeter. The kinetic energy given off by the body as heat and external muscular work, and the potential energy (heat of combustion) of food, drink, feces, and urine, give data for calculating the income and outgo of energy of the body.

In the respiration calorimeter the appliances for the measurement of both the respiratory products and the heat generated differ in important respects from those of other apparatus used for this purpose. Measurements of temperature are made electrically and are very delicate, differences of one-hundredth of one degree being easily determined. In tests of the apparatus and methods of experimenting with it, the measurements of carbon dioxide, water and heat are found to differ by only a few thousandths of the whole. The apparatus may therefore be regarded as one of precision.

The general plan of the experiments consists in giving the subjects a diet which furnishes the different nutrients in the amounts and proportions appropriate to the question under investigation, and in determining, as indicated above, the chemical elements and compounds and the energy of both the income and outgo. The income and outgo of energy in the body has been determined by this apparatus in 20 experiments made with three men and covering a period of 63 days. The ratio of potential energy (heat of combustion) of the material oxidized in the body to the kinetic energy given off from the body in the form of heat and (heat equivalent of) external muscular work in all of these experiments together was as 1,000 to 999+. This implies that practically all of the potential energy of the food was transformed into measurable kinetic energy in accordance with the law of the conservation of energy. In other words, the inference is fair that the law of the conservation of energy obtains in the living organism.

By observing the actual income and outgo of matter and energy in the body with different kinds and amounts of food and under different conditions of rest and work, the transformations of material and energy can be studied. In this way light is thrown upon the fundamental laws of nutrition, the nutritive values of different food materials and their adaptation to the demands of the body.

In studying the various problems it is desirable to experiment with as large a variety of materials as possible. To that end alcohol has been included in the daily menu in a number of the experiments. In the form of commercial alcohol, brandy or whisky, the equivalent of 2½ ounces of absolute alcohol has been given in six doses every 24 hours. It was given in coffee or water with a diet of bread, meat, milk, sugar, butter, etc. The small doses were given in order to avoid any marked effect upon the nerves, as the object was to study the action of alcohol under normal bodily conditions. In some of the experiments the alcohol was added in place of an isodynamic amount of sugar, starches and fats, while in others it was simply added to the diet without the withdrawal of any of the ingredients. The special object was to study the nutritive value of alcohol, especially as compared with that of the fuel ingredients of the diet.

The results of ten such experiments, with two subjects, when compared with a like number of experiments without alcohol, may be briefly stated as follows:

First, extremely little of the alcohol was given off from the body unconsumed; indeed, it was oxidized as completely as bread, meat or any other food. Second, in the oxidation, all of the potential energy of the alcohol was transformed into heat or muscular work. In other words, the body transformed the energy of the alcohol as it did that of sugar, starch and other ordinary food materials. Third, taking the experiments together, the body held its own just as well with the rations consisting partly with alcohol as it did with the others. This was the case whether the men were at rest or work, and whether the rations were or were not adequate to the needs of their bodies for nourishment. In other words, so far as the figures for income and outgo of chemical elements and compounds in these experiments show, the alcohol protected the nitrogen and carbon, the proteids and fats, of the body from consumption as effectively as the carbonaceous nutrients which it replaced. There were indeed variations in the figures from day to day and from experiment to experiment. In some cases, judging by the figures as they stand, the alcohol appeared to be less, in others it appeared to be more, efficient than the sugar, starch, and fat, in protecting either the nitrogen or the carbon of the body from consumption. In certain instances there were large losses, in others gains, of either nitrogen or carbon, or both. But these variations were in general about as large and frequent with the rations without alcohol as with the corresponding rations with alcohol. Taking the experiments altogether we should not be warranted in saying that the results establish any difference between the two kinds of rations in this respect.

Prof. Atwater does not, however, regard the results of these experiments as final. These experiments, which are more detailed than any others of the sort of which I have been able to find descriptions, imply, so far as they go, that isodynamic amounts of fats, sugar, and starch, on the one hand, and alcohol on the other, are of equal value to the body as fuel. To put it in another way, one ounce of alcohol, when burned with oxygen in an apparatus for the purpose, will yield about the same amount of heat as, say, three-fourths of an ounce of fat or an ounce and three-quarters of either sugar or starch. But whether the body gets the same benefit from the ounce of alcohol as from the three-quarters of an ounce of fat or the ounce and three-quarters of starch or sugar is another matter. The body uses the sugar, starch, and fat for a variety of purposes. It may be that the isodynamic amounts of these carbonaceous nutrients have equal values for some of these purposes and unequal values for others, the value depending upon the kind of service. So likewise it may be that the value of alcohol as fuel depends upon the kind of work it is to do. For aught we know to-day, there may be forms of service as fuel which it cannot render, or can render only under special conditions.

One of the questions still unsettled is the value of alcohol as a protector of body protein. There are a number of experiments on record in which the nitrogen balance was not maintained as well with alcohol as without it. A series of experiments with another subject than those of the experiments mentioned above show important differences in this respect, with apparently an indication of less protection of body protein by a diet with alcohol. One of the interesting problems now before us is to find the reason for these differences, whether they depend upon the individual or upon the food or upon the bodily condition or otherwise. With what persons or under what circumstances alcohol is or is not equivalent to the isodynamic amount of either fat, starch or sugar, in respect to the protection of the body protein, future inquiry must decide.

These experiments had to do simply with the nutritive action of alcohol, but do not prove that alcohol is a desirable food. They have very little bearing upon its indirect action, which may affect its nutritive value; neither do they indicate what are its effects when taken habitually for months or years.

(To be continued.)

The postage stamp collection of M. Ferrari, nephew of the late Duchess of Galliera, is valued at $1,400,000, and the collection of M. Mirabaud is said to be worth $420,000. A postage stamp exhibition is now being held in Paris, and two Mauritius stamps shown are valued at $10,500.

THE BRIAR ROOT INDUSTRY IN ITALY.

THE wood from which briar pipes are made is the root of the large heath known in botany as the Erica arborea. Our "briar" is but a corruption of the French bruyère. The British Vice-Consul at Leghorn states that the briar root industry has had a somewhat curious history. First begun in the Pyrenees some fifty years ago, it traveled along the French Riviera and the Ligurian coast (taking Corsica by the way), to the Tuscan Maremma, and has now reached Calabria, in the south, which is at present its most flourishing center. By the very nature of the business, when a certain district has been exhausted of all its roots, the industry must come to an end there, and the opinion has been expressed that the Italian branch of it cannot last much more than another ten years. Leghorn has always been the center of the export of Tuscan briar root since the Maremma industry came into existence, but as the South Italian briar is of admittedly superior quality, a large quantity of the Calabrian root is also imported into Leghorn for selection and subsequent export. The total export from Leghorn is estimated at 50,000 cuts a year, valued at £28,000. Fully one-half the export is Calabrian root. All the root that comes into Leghorn has already been cut on the spot into the shape in which it is exported to the pipe manufacturing centers, which are principally—at least as regards Italian briar—St. Claude in France, Nuremberg in Bavaria, and various towns in Rhenish Prussia and Thuringia. The roots, which are sometimes of a circumference of two feet or more, are cut into blocks and then boiled. If there is any defect in the root which has not been discovered before the boiling process, the blocks are bound to split sooner or later. Briar-root blocks are cut into about 25 different sizes, and three principal shapes. The shapes are "Marseillaise," "Relevé," and "Belgian." The first two are the more usual shapes; from the "Marseillaise" blocks are cut the ordinary briar pipes which have bowl and stem at right angles; "Relevé" blocks are cut into a shape for converting into hanging pipes; and "Belgian" blocks, for which there is but small demand, are shaped to fashion into pipes which have bowl and stem at an obtuse angle. The minimum size of "Marseillaise" blocks is about three inches in length, two inches in depth, and one and a half inches in width. The Calabrian blocks, selected at Leghorn and exported thence, seem to be in favor with the trade, for the reason that they remain so long on the dealer's hands that they would be almost certain to split before export if they were defective. A Leghorn dealer, who does his own cutting in Calabria, has first to have the roots sent by wagon to his workshops, where they are boiled and cut, thence again by wagon to the sea coast, where they are placed in lighters for shipment to Leghorn. At Leghorn they are once more transferred to lighters and placed in carts for transport to the warehouses, where they are unpacked for selection. They are then repacked in bales and carted to the goods station for conveyance abroad, but a considerable time must elapse before they leave the hands of a merchant who does his own cutting in Calabria. A considerable quantity of blocks is sent to the United States, but apparently none to the United Kingdom.

PRESERVATION AND USE OF GELATINE ROLLERS.

THOSE who know how difficult it is to cast good, durable rollers, and how expensive it is to replace them, will appreciate the following instructions given by H. Gauger, manufacturer of printer's inks, in the Photographische Chronik: The rollers should be kept in a dry place at a uniform, moderate temperature. The rollers should be cast from uniform material, and, if possible, in the autumn (September to October) for winter use, and in the spring (April to May) for summer use. Inking rollers should only be cast or recast from fresh material, and should be allowed to stand a few days before use, to season. Old composition should only be employed for casting rollers that are not used for inking blocks, writing, etc. In recasting old rollers, they should be first washed clean and the skin removed with hot water. The ends, and all cuts and holes, in which ink may have lodged, should be removed with a sharp knife. The composition should then be stripped off the spindle, broken in small pieces, and thrown in the melting-pot. The receptacle in which the composition is dissolved should not be heated by steam, but in a hot-water jacket, otherwise the composition may be overheated and spoilt. The mould should be warmed, especially at the bottom, but it should not be hotter than the hand can bear. This may best be done with a handful of cotton waste saturated with spirit, suspended by wire inside the mould, near the bottom, and burnt. When the mould is warm, smear it thinly and evenly with olive oil or fresh pork fat. The spindle should be warmed before placing it in the mould, and it should be perfectly dry. Small iron spindles may be wound round with cotton thread, but in this case it is better to prepare them the previous day by fastening the thread to the spindle with Cologne glue. When the composition is completely dissolved and fluid (the temperature should never exceed 60° C.), the mould should be filled in a place free from draught, by pouring the composition gently down the spindle, making occasional pauses of two or three minutes each. When the mould is full, set it up near the fire to allow any bubbles to rise. The mould should be allowed to cool down gently for about eight to ten hours, and the roller may then be withdrawn. It should be cleaned with a sponge dipped in benzine to remove the grease, and should not be used for a couple of days. No admixture (crême) should be added to the composition taken from old hard rollers, unless softer rollers are required for winter use, and then the proportion should not exceed ten per cent. The reserve set of rollers should be kept in a cupboard to preserve them from draught and dust. In damp localities, or in damp weather, the rollers should be covered with a coating of very thin newspaper ink (old bad ink, mixed with lubricating oil), which should be removed before use. This prevents swelling or shrinkage. The washing of rollers should be carefully avoided. If, however, it must be done to change the color of the ink, first clean the rollers with waste paper, then with petroleum, and finally with benzine.—British Journal of Photography.

VALUABLE BOOKS

AN AMERICAN BOOK ON

Horseless Vehicles, Automobiles and Motor Cycles.

OPERATED BY

Steam, Hydro-Carbon, Electric and Pneumatic Motors.

By GARDNER D. HISCOX, M.E.

This work is written on a broad basis, and comprises in its scope a full illustrated description with details of the progress and manufacturing advance of one of the most important innovations of the times, contributing to the pleasure and business convenience of mankind.

The make-up and management of Automobile Vehicles of all kinds is liberally treated, and in a way that will be appreciated by those who are reaching out for a better knowledge of the new era in locomotion.

The book is up to date and very fully illustrated with various types of Horseless Carriages, Automobiles and Motor Cycles, with details of the same. Large 8vo. About 450 pages. Very fully illustrated. Price **$3.00**, postpaid.

GAS ENGINE CONSTRUCTION.

By HENRY V. A. PARSELL, Jr., Mem. A. I. Elec. Eng., and ARTHUR J. WEED, M.E.

PROFUSELY ILLUSTRATED.

This book treats of the subject more from the standpoint of practice than that of theory. The principles of operation of Gas Engines are clearly and simply described, and then the actual construction of a half-horse power engine is taken up.

First come directions for making the patterns; this is followed by all the details of the mechanical operations of finishing up and fitting the castings. It is profusely illustrated with beautiful engravings of the actual work in progress, showing the modes of chucking, turning, boring and finishing the parts in the lathe, and also plainly showing the lining up and erection of the engine.

Dimensioned working drawings give clearly the sizes and forms of the various details.

The entire engine, with the exception of the fly-wheels, is designed to be made on a simple eight-inch lathe, with slide rests.

The book closes with a chapter on American practice in Gas Engine design and gives simple rules so that anyone can figure out the dimensions of similar engines of other powers.

Every illustration in this book is new and original, having been made expressly for this work.

Large 8vo. About 300 pages. Price **$2.50**, postpaid.

MECHANICAL MOVEMENTS,

Powers, Devices, and Appliances.

By GARDNER D. HISCOX, M.E.

A Dictionary of Mechanical Movements, Powers, Devices and Appliances, embracing an illustrated description of the greatest variety of mechanical movements and devices in any language. A new work on illustrated mechanics, mechanical movements, devices and appliances, covering nearly the whole range of the practical and inventive field, for the use of Machinists, Mechanics, Inventors, Engineers, Draughtsmen, Students and all others interested in any way in the devising and operation of mechanical works of any kind.

Large 8vo. 400 pages. 1,649 illustrations. Price **$3.**

Liquid Air and the Liquefaction of Gases.

By Prof. T. O'CONOR SLOANE.

This book contains the full theory of the subject. It gives the entire history of the Liquefaction of Gases from the earliest time to the present, and contains an illustrated description of all the experiments that have excited the wonder of audiences all over the country. It is a logical explanation and application of the principles of liquefaction, a history of the theory, discovery and manufacture of liquid air. A book that renders simple one of the most perplexing chemical problems of the century. Startling developments illustrated by actual experiments. It is not only a work of scientific interest and authority, but is intended for the general reader, being written in a popular style—easily understood by everyone.

365 pages. With many illustrations. Price **$2.50.**

THE SCIENTIFIC AMERICAN

Cyclopedia of Receipts, Notes and Queries

Edited by ALBERT A. HOPKINS.

This splendid work contains a careful compilation of the most useful Receipts and Replies given in the Notes and Queries of correspondents as published in the SCIENTIFIC AMERICAN during the past fifty years, together with many valuable and important additions.

Over twelve thousand selected receipts are here collected; nearly every branch of the useful arts being represented. It is by far the most comprehensive volume of the kind ever placed before the public.

12,500 receipts. 768 pages. Price **$5** in cloth; **$6** in sheep; **$6.50** in half morocco; postpaid.

A COMPLETE ELECTRICAL LIBRARY.

By Prof. T. O'CONOR SLOANE.

An inexpensive library of the best books on Electricity. Put up in a neat folding box. For the student, the amateur, the workshop, the electrical engineer, schools and colleges. Comprising five books as follows:

Arithmetic of Electricity, 138 pages	$1.00
Electric Toy Making, 140 pages	1.00
How to Become a Successful Electrician, 180 pages	1.00
Standard Electrical Dictionary, 682 pages	3.00
Electricity Simplified, 158 pages	1.00

Five volumes, 1,300 pages, and over 400 illustrations.

A valuable and indispensable addition to every library.

Our Great Special Offer.—We will send prepaid the above five volumes, handsomely bound in blue cloth, with silver lettering, and inclosed in a neat folding box, at the **Special Reduced Price of $3.00** for the complete set. The regular price of the five volumes is $7.00.

Gas, Gasoline, and Oil Vapor Engines.

The Only American Book on the Subject.

By GARDNER D. HISCOX, M.E.

A book designed for the general information of every one interested in this new and popular motive power, and its adaptation to the increasing demand for a cheap and easily managed motor requiring no licensed engineer.

The book treats of the theory and practice of Gas, Gasoline and Oil Engines, as designed and manufactured in the United States. It also contains chapters on Horseless Vehicles, Electric Lighting, Marine Propulsion, etc. 270 handsome engravings. Large Octavo, 325 Pages. **$2.50.**

EXPERIMENTAL SCIENCE.

By GEORGE M. HOPKINS.

This is a book full of interest and value for teachers, students and others who desire to impart or obtain a practical knowledge of Physics.

This splendid work gives young and old something worthy of thought. It has influenced thousands of men in the choice of a career. It will give anyone, young or old, information that will enable him to comprehend the great improvements of the day. It furnishes suggestions for hours of instructive recreation.

20th edition. Revised and enlarged. 914 pages. 830 illustrations. Elegantly bound in cloth. Price, by mail, postpaid, **$4.00**; Half Morocco, **$5.00.**

MAGIC

Stage Illusions and Scientific Diversions, including Trick Photography.

By A. A. HOPKINS.

The work appeals to old and young alike, and it is one of the most attractive holiday books of the year. The illusions are illustrated by the highest class of engravings, and the exposés of the tricks are, in many cases, furnished by the prestidigitators themselves. Conjuring, large stage illusions, fire-eating, sword-swallowing, ventriloquism, mental magic, ancient magic, automata, curious toys, stage effects, photographic tricks, and the projection of moving photographs are all well described and illustrated, making a handsome volume. It is tastefully printed and bound. Acknowledged by the profession to be the **Standard Work on Magic.** 568 pages. 425 illustrations. Price **$2.50.**

☞ *Full descriptive circulars of above books will be mailed free upon application.*

MUNN & CO., Publishers, 361 Broadway, N. Y.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents and canvassers.

MUNN & CO., Publishers, 361 Broadway, New York.

TABLE OF CONTENTS.

PAGE

I. AGRICULTURE.—Antiquity of Agriculture 20708

II. ARCHÆOLOGY.—Roman and Gallo-Roman Flour Mills.—6 illustrations 20714

III. BOTANY AND HORTICULTURE.—Roupellia Grata.—1 illustration 20715

IV. CHEMISTRY.—Chemical and Technical Education in the United States.—By Prof. C. F. CHANDLER 20715

V. COMMERCE.—Commercial Relations Between the United States and Spain 20713
Trade Suggestions from United States Consuls 20709

VI. ELECTRICITY.—Contemporary Electrical Science 20711
Wireless Telephony 20708

VII. FOLK LORE.—Ashanti Fetishes and Oracles 20715

VIII. FUELS.—Indian Coal 20713

IX. HOROLOGY.—A Curious Clock 20708

X. MECHANICAL ENGINEERING.—American Engineering Competition.—XII.—Machine Tools 20704
The Westinghouse Gas Engines.—5 illustrations 20705

XI. METEOROLOGY.—Remarkable Effects of the Indian Earthquake 20711

XII. MILITARY SCIENCE.—Swimming Exercises of the Prussian Army.—2 illustrations 20710

XIII. MISCELLANEOUS.—The Briar Root Industry in Italy 20718
Trade Notes and Receipts 20708

XIV. NAVAL ENGINEERING.—The French Navy.—12 illustrations 20703

XV. SCIENCE.—Inaugural Address of Prof. Sir WILLIAM TURNER. 20712
The Progress of Science and Invention 20710

XVI. TECHNOLOGY.—Preservation and Use of Gelatine Rollers ... 20718

XVII. WARFARE.—Facts About "Militarism" 20712

Automobiles

The SCIENTIFIC AMERICAN for May 13, 1899, is devoted mainly to illustrations and detailed descriptions of various types of horseless vehicles. This issue also contains an article on the mechanics of the bicycle and detailed drawings of an automobile tricycle. Price 10 cents.

The following copies of the SCIENTIFIC AMERICAN SUPPLEMENT give many details of Automobiles of different types, with many illustrations of the vehicles, motors, boilers, etc. The series make a very valuable treatise on the subject. The numbers are: 732, 979, 993, 1053, 1054, 1055, 1056, 1057, 1058, 1059, 1075, 1078, 1080, 1082, 1083, 1099, 1100, 1113, 1122, 1178, 1195, 1199, 1206, 1210. SUPPLEMENT No. 1229 contains a highly interesting article giving full data as to operating costs of horse and electric delivery wagons in New York city. Price 10 cents each, by mail. For sale by all newsdealers, or address

MUNN & CO., Publishers,

361 Broadway, - - - New York City.

BUILDING EDITION

OF THE

SCIENTIFIC AMERICAN.

Those who contemplate building should not fail to subscribe.

ONLY $2.50 A YEAR.

Semi-annual bound volumes $2.00 each, yearly bound volumes $3.50 each, prepaid by mail.

Each number contains elevations and plans of a variety of country houses; also a handsome

COLORED PLATE.

SINGLE COPIES - - - - 25 CENTS EACH.

MUNN & CO., 361 Broadway, New York.

PATENTS!

MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for Inventors.

In this line of business they have had *over fifty years' experience*, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. MUNN & CO. also attend to the preparation of Caveats, Copyrights for Books, Trade Marks, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge on application containing full information about Patents and how to procure them; directions concerning Trade Marks, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases, Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,

361 Broadway, New York.

BRANCH OFFICES.—No. 625 F Street, Washington, D. C.